ENGINEERING REPORT - DRAFT

Crescent Beach Contamination Remediation – Alternatives Evaluation

Glen Cove, New York

H2M Project No.
GLCV 19-01

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1.0 INTRODUCTION

Crescent Beach (Beach ID NY529956), the smallest of the three City of Glen Cove (City) public beaches, is located on the north shore of Long Island (Picture 1). Only Glen Cove residents may use the beach. Due to bacteriological indicators, Crescent Beach has been closed to the public since the summer of 2009. This notification is posted on the restroom building in the parking area at the north end of Crescent Beach Road.

Access to the beach is from the parking lot at the north end of Crescent Beach Road. There is no vehicular access to the beach from the parking lot. A restroom is located at the north end of the parking lot. Attendants monitor beach use from Memorial Day weekend through Labor Day.

The beach and the drainage area for the creek that discharges to the Long Island Sound to the west of the beach is located within New York State Hydrologic Unit Code 020302030000. The Water Index Number for the Long Island Sound, Nassau County, Central (1702-0028) is MW4.1 and the surface water classification is SA. Public bathing use in this portion of the Long Island Sound is known to be impaired by pathogens.

Picture 1 – EPA Aerial with Delineation of Crescent Beach

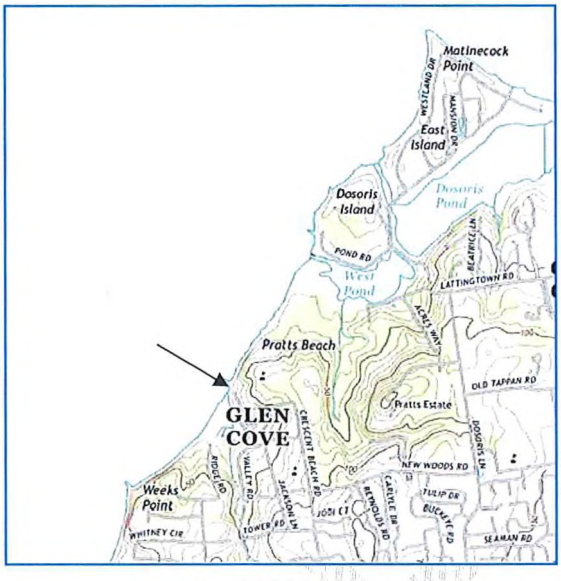
Since closure of the beach, the City has conducted several studies to determine the source of the contamination. The objective of the project, in accordance with the Intermunicipal Agreement between the County of Nassau and the City of Glen Cove, is to provide a cost-effective method that will remedy the contamination to allow Crescent Beach to reopen to the public. Five alternatives to remedy the bacteria contamination of Crescent Beach are evaluated in this report.

Picture 2 – Crescent Beach

2.0 EXISTING CONDITIONS

Crescent Beach is located on Nassau County Tax Lot Section 31, Block 51, Lot 502 and 509. A creek discharges in about the middle of the beach. A spring fed pond on Nassau County Tax Lot Section 31, Block 51, Lot 103 contributes dry weather flow to the creek. A pond fed by a well on Nassau County Tax Lot Section 31, Block 31, Lot 10 contributes dry weather flow to wetland area that also drains to the creek.

Picture 3 indicates the location of the beach on a USGS map.



Picture 3 – USGS Location Map

Data on the EPA BEACON website indicates that prior to the fulltime closure in 2009, the beach was closed preemptively for rainfall 4 days in 2005 and 8 days each in 2006, 2007 and 2008. Over the past six beach seasons, the Enterococci bacteria concentration exceeded the daily threshold of 104/100 ml ranged from 6 to 14 days. On days when samples were collected and results exceeded the limit, there is no consistency on which of the three locations has the highest concentration. There are days when the right and left samples are not in compliance while the sample in the center of the beach is in compliance or has the lowest value.

In addition to the beach closure for public contact with the waters, the surface waters within 250 yards of the seaward end of the rock jetty at the City of Glen Cove's Crescent Beach at the foot of Crescent Beach Road are uncertified for shellfishing.

3.0 NASSAU COUNTY DEPARTMENT OF HEALTH REQUIREMENTS

The Nassau County Department of Health (NCDH) has regulatory jurisdiction on the operation of beaches in the County. Sampling and regulatory requirements were reviewed with Mr. Andrew Wendolovske of the NCDH.

Water samples are collected by the NCDH on Monday, Tuesday and Wednesday beginning in mid-April and ends in late September. Sampling begins in mid-April to allow calculation of the 30-day geometric mean before a beach is opened. NCDH personnel have a regular route to allow samples to be collected at approximately the same time each day. The person collecting the sample stands knee deep in the water and grabs a sample 1 foot below the surface. Samples are collected at the center of the roped bathing area and the left and right limits. Data from the New York State Department of Health for 2014 through August 26, 2019 is presented in Appendix A.

County sampling personnel are seasonal staff. The sampler does not record if the tide is incoming or outgoing when the samples are collected. General wind direction and speed may be noted. When the beach reopens, City beach staff should note in the daily log tidal conditions when the County collects samples. Should there be a water quality issue in the future, this will help to determine the potential source of contamination.

New York State beach water quality standards are specified in Subpart 6-2 of the State Sanitary Code. The maximum allowed enterococci concentration for a single sample is 104 per 100 milliliters (ml) in marine water and 61 per 100 ml in fresh water. For E. coli, the maximum concentration is 235 per 100 ml. However, E. coli cannot used to assess marine water. There are also standards for a 30-day geometric mean - 35 enterococci/100ml for marine water and 33 enterococci/100ml or 126 E. coli/100ml in freshwater.

New York State regulations are expected to be revised for the 2020 bathing season that will lower the maximum allowed enterococci concentration for a single sample to 60 per 100 milliliters (ml) and a 30-day geometric mean of 30 enterococci/100ml in marine water. Beaches are pre-emptively closed following a rainfall of 0.5-inches or greater for two tidal cycles after a non-complying sample.

The New York State Department of Health website notes Enterococci and E. coli bacteria can come from the same sources as pathogenic organisms, such as sewage discharges, failing septic systems, storm water runoff, pet and agricultural waste, gulls, and geese. However, it has been demonstrated that enterococci and E. coli can also be present in sediments and algae material in quantities that can affect the beach water.

A report from the NYSDEC indicates coliform contamination is from animals. Signs should be posted to remind people to curb dogs on the beach and in the drainage area tributary to the beach. Signs should also be posted to not feed waterfowl at and around the beach.

4.0 DESIGN FLOWS

The remediation system alternatives need to consider the dry weather flow and the wet weather flow.

4.1 Dry Weather Flow

A site visit to the drainage area was conducted on April 18, 2019. During the visit, we were allowed access by staff on the Schein Estate (Section 31, Block 51, Lot 103). A weir approximately 2-feet wide is at the outlet to the groundwater fed pond (Picture 4). Based on the height of flow over the weir, the flow rate from the pond at the time of the visit was approximately 25 gallons per minute (gpm).

Picture 4 – Outlet at Groundwater Fed Pond

A site visit was conducted late on the afternoon on May 4 to conduct flow measurements of the creek onto the beach during low tide. Measurements were made when no precipitation was falling though there was rain earlier in the day. A temporary 1-foot x 1-foot rectangular weir cut in the top of a sheet of 2 x 4 x 7/16 plywood. The weir was installed in the tidal zone approximately 12 feet south of the northerly end of the retaining wall. The downstream edge of the opening in the plywood was beveled. Liquid level was measured 1-foot upstream down from the leg of a framing square placed on top of the weir. Photos 5 and 6 show the placement of the temporary weir. The flow rate at the time of the measurement was approximately 100 gpm.

Picture 5 – Temporary Weir Location

Picture 6 – Temporary Weir Before Flow Measurement

4.2 Wet Weather Flow

A Drainage Area Map identifying watershed boundaries, flow paths and design points was developed to delineate the contributing stormwater runoff areas (drawing at end of the report). The specific watershed boundaries were determined using USGS topographic maps and data. For comparative analysis, the contributing area has been separated into two sub-watersheds and a corresponding point of analysis; Drainage Area 1 and Drainage Area 2 both drain to Point of Interest 1 (POI-1). Runoff from each of these areas will drain towards and discharge across Crescent Beach. In reviewing the topographic maps, it was determined that the watersheds generally slope north and west with grades ranging from 2% to 5%. The highest elevation is approximately 160 feet. Drainage generally follows a path adjacent to Valley Road and Cobble Court. Based on the USGS maps and Nassau County Tax Maps showing the lots in the surrounding neighborhoods, the drainage areas consist mostly of developed 1-acre residential lots and roadways.

As stated in the NYSDEC Stormwater Design Manual, Chapter 4, Table 4.2, the mean impervious cover for a 1-acre residential lot is 14%. Therefore, Drainage Area 1 and Drainage Area 2 were modeled as having 14% impervious cover and 86% pervious cover. A summary of the drainage area cover conditions is shown in Table 01 below:

Table 01 – Drainage Area Conditions

Watershed ID	Watershed Area (ac)	Impervious Area (ac)	Percent Impervious (%)	Pervious Area (ac)	Percent Impervious (%)
Drainage Area 1	66.80	9.35	14	9.35	86
Drainage Area 2	149.70	20.96	14	128.74	86

Stormwater Modeling

Stormwater runoff from the watershed areas was modeled to calculate the peak-runoff flow rate for a 1-hour storm event with a resulting rainfall depth of 0.5 inches. This storm simulates a typical heavy rain event over soils that are saturated, creating a scenario of the maximum stormwater runoff for this event. The runoff modeling and analysis was completed using the SewerGEMS V8i software and the SCS Unit Hydrograph method.

Within SewerGEMS, the contributing watersheds were modeled with their respective ground cover and soil conditions. All impervious cover was defined as paved driveways, streets, parking lots and roofs resulting in a Curve Number of 98 and the pervious cover was defined as grass cover with saturated soils resulting in a Curve Number of 89.

Time of Concentration (Tc) values for the watershed cover conditions were determined using the TR-55 methodology and Worksheet 3 of TR-55. The resulting Tc values were 0.39 hours and 0.64 hours for Drainage Area 1 and Drainage Area 2 respectively.

In the model, the stormwater runoff from each of the drainage areas was directed to a single design point, POI-1. After running the SewerGEMS model, the peak-runoff flow rate as a result of the 1-hour storm event was calculated to be 13.19 cfs.

A summary of the peak flow rates for the drainage areas and design point is provided in Table 02 below:

Table 02 – Stormwater Modeling Summary

Watershed ID / Design Point	Peak Runoff (cfs)	Peak Flow (cfs)
	1-Hr 0.5" Storm	
Drainage Area 1	4.61	
Drainage Area 2	9.00	
POI-1		**13.61**

5.0 REMEDIATION ALTERNATIVES

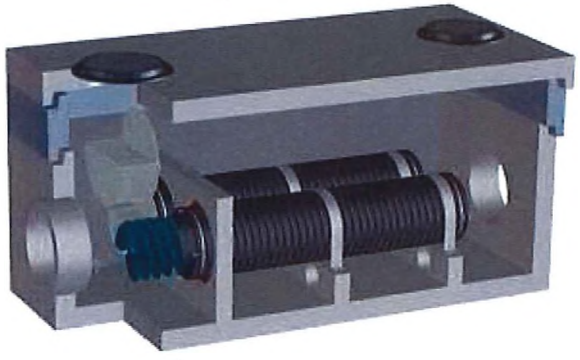
The following remediation alternatives were considered to address the bacteria contamination in the flow from the creek that discharges on Crescent Beach:

- Helix System
- Ultraviolet System
- Dry Weather Flow Outfall
- Ecological Restoration
- Beach Management

5.1 Helix System

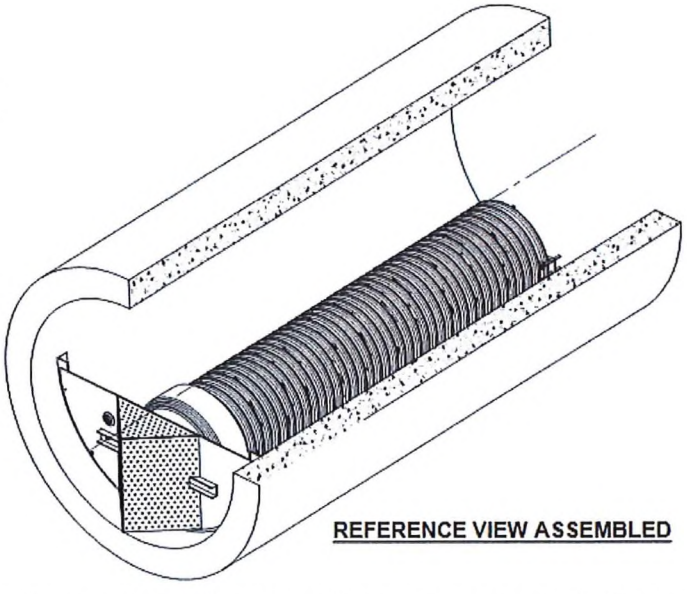
The Helix, manufactured by Fabco Industries, is a high-flow stormwater filter that can be housed in a vault or installed directly into an outfall pipe. When applied with Fabco's FABGUARD antimicrobial media, the filter can treat bacteria. Fabguard is an EPA registered antimicrobrial pesticide. Manufacturer's information indicates results from a Fabco beach study project demonstrated average E.Coli and Fecal coliform reductions of 70%. Based on the monitoring data, this level of reduction, if achieved, would help improve water quality for a significant number of samples. The horizontal filter column design provides flexibility for selecting the appropriate filter length and diameter for a given flow rate. The Helix elements inside the column(s) function as a multiple disk filter providing a large amount of surface area for treatment. The spiral form offers multiple flow paths through the filter which allows the system to maintain a high flow rate while significantly reducing clogging potential.

Each Helix filter column has a design treatment flow rate of approximately up to 3 cubic feet/sec (1,346 gallons/minute) based on diameter. The manufacturer offers Helix filters in single, double and triple column systems. Filter cartridges are replaceable and can be accessed through a standard 36-inch diameter manhole covers provided in the top of the vault. A two-column system within a precast concrete vault is in the photo below.



To keep debris that passes through the sediment separator out of the filter column, each Helix filter column is supplied with an inlet diffuser. A full overflow bypass is also provided for each Helix.

Due to the logistics of construction in an environmentally sensitive area, the Helix can also be installed within a pipe. Flow that exceeds the design capacity of the pipe with the Helix would be routed around the unit. This is the proposed configuration for the Crescent Beach Remediation. Compared to the vault configuration, this concept should be more functional and aesthetically pleasing. Replacement of the filters within the pipe would be by pulling out the existing elements and pushing in new elements would not require a confined space entry.



REFERENCE VIEW ASSEMBLED

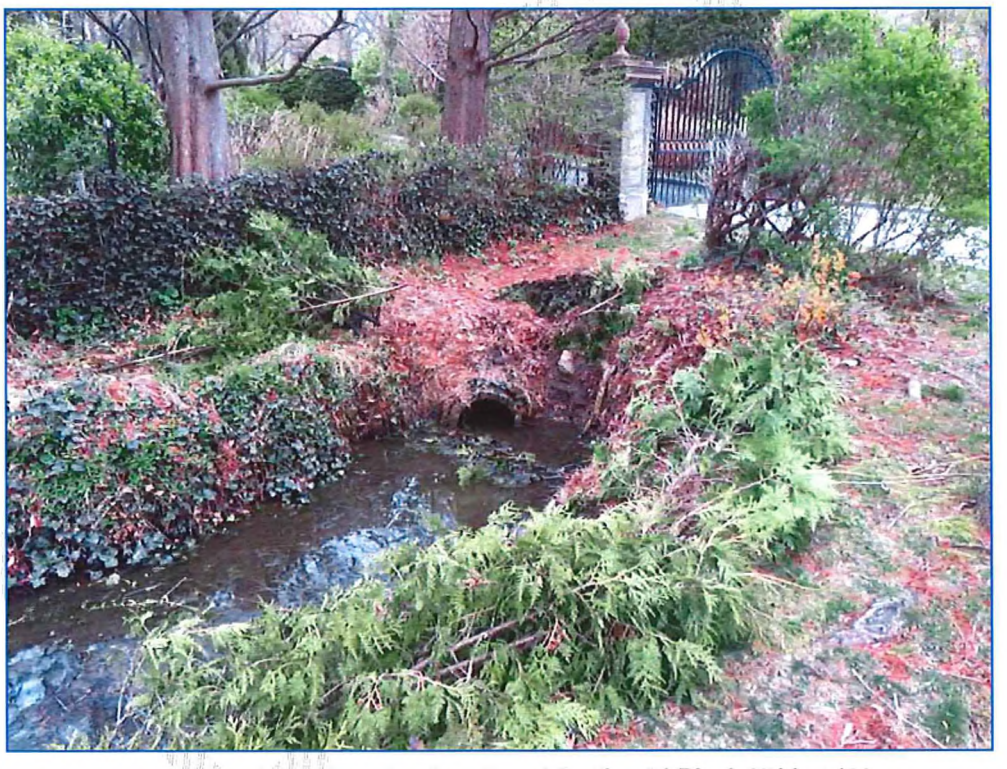
For the .33 cfs design flow, a 24-inch diameter helix system would use 5 filter elements approximately 14 to 15-feet in total length. The filters elements would be placed within a plastic pipe as an insert in a 36-inch or 48-inch diameter concrete or HDPE culvert pipe that would allow higher flows to pass around the pipe. The pipe sizing will be established during the design phase. A custom metal trash barrier would be installed at both ends of the culvert pipe. The barriers would also serve as safety devices as a means to

prevent anyone from attempting to gain access into the pipes. Sediment control would be provided upstream and downstream of the culvert to help drop out sediment.

If the system is operated seasonally, the filters may be removed, rinsed and drained then stored during the off-season. The manufacture suggests that the elements be stored in a temperature/humidity controlled area will also be beneficial for the elements. The manufacturer indicates they have not experienced issues with a reduction in effectiveness on units that are stored after wet then dry cycles.

Representatives in Travis City Michigan were contacted to review their operating experience for the East Bay Park Stormwater Quality system installed in the spring of 2013 to reduce pathogen levels.

There are two ponds within the drainage area that have flow year-round. Discharge to the watershed from each pond is through a pipe (Pictures 7 and 8).



Picture 7 – Outlet from Pond on Parcel Section 31 Block 051 Lot 103

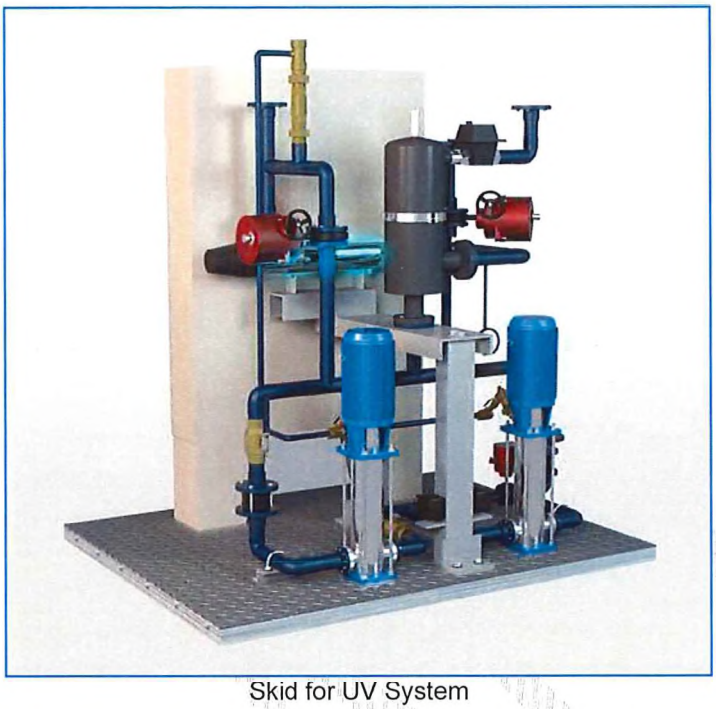
A Helix system could be installed in the outlet piping from each pond prior to discharge into the waters tributary to Crescent Beach. A 24-inch diameter helix system would use one filter element approximately 2.5-feet in total length. To install each unit, excavation will be required to install the vault, and pipe connections. The size of the vault and type of access into the vault may be revised following topographic survey, underground utility mark-out and flow measurements.

Picture 8 – Outlet from Pond on Parcel Section 31 Block 031 Lot 10

5.2 UV System

Disinfection is the destruction of pathogenic microorganisms that are harmful to plant life and aquatic life. Ultraviolet (UV) irradiation effectively inactivates pathogens to achieve disinfection levels. The radiation energy of UV rays is used to destroy microorganisms. In order to kill the microorganisms, the electromagnetic waves of ultraviolet irradiation must actually strike the organisms. UV treatment does not alter water chemically; nothing is being added except energy, which produces heat, resulting in a slight temperature rise in the treated water. The damage incurred by UV absorption is the demerization of thymine, one of the components of DNA. This damage disables bacteria and viruses in such a way that they are unable to replicate and are inactivated. The only radiant energy effective in killing bacteria is that which reaches the bacteria; therefore, the water must be free particles that would act as a shield. Turbidity will hinder the disinfection properties of the UV system, as UV light must be received from all angles. Pretreatment needs to be provided before flow enters the UV system. A control panel would be located adjacent to the equipment skid. The panel would include monitors and controls of the UV system.

A concept for the UV system is to use a skid mounted equipment that would draw water to and through a treatment system. A structure would be installed in the creek to provide a retention basin for the pump suction. The structure would be installed at an elevation above mean higher-high water. After passing through the treatment system, the water would be discharged on the downstream side of the retention structure. This will maintain the natural flow of water in the creek.



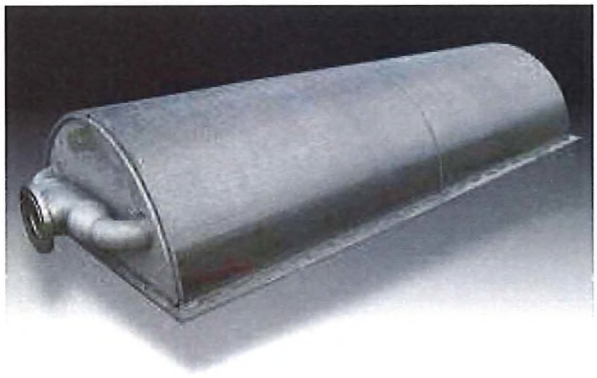
Skid for UV System

The structure to be constructed in the stream would have a weir to allow storm flow above the treatment system design flow to flow in the creek. To limit energy consumption, the system's filter will be selected to minimize backwash volume and the pumps will be optimized with variable frequency drives. The proposed alternative to use UV to inactivate bacteria avoids the use of chemical. The system will require an electric service.

The effectives of ultraviolet (UV) decreases rapidly with an increase in turbidity of the water. A coarse box strainer will be provided on the suction line in the creek followed by a basket strainer to protect the UV lamps from debris.

Box Strainer for UV Treatment System Intake

An alternate to the box strainer is a barrel type intake screen.



Screen for UV Treatment System Intake

Both types of intakes would need periodic maintenance to remove debris that could accumulate on the equipment.

The maintenance for the ultraviolet system basically consists of keeping the lamps clean and maintaining the proper lamp intensity level. The UV intensity level should be recorded daily. An UV transmission test should be performed each day.

Ultraviolet light can cause serious burns to skin and eyes. Always take necessary precautions to ensure safety. Never peek at the UV lamps unless the lamps are turned off and have been properly locked out and tagged out. Protective glasses should be worn if there is a need to look at lamps while they are on. A unit should not be turned on without having the lamps properly secured in the chamber and closing the cover. UV lamps may contain mercury vapor. Mercury vapor is a hazardous substance that is released when the lamp is broken. Handle UV lamps with extreme caution and have proper equipment available to clean up any spills.

5.3 Drainage Outfall

Under this alternative, a pipe will be installed to convey by gravity the dry weather surface flow. Freshwater from the creek is lighter than the salt water in Long Island Sound. A subsurface pipe with an outfall diffuser a sufficient distance from the beach may provide a method to remedy the bacteria contamination and reduce life cycle cost when compared to the two treatment systems. NOAA Chart 12366 indicates a sounding depth of more than 20 feet approximately 1000 feet from the shoreline.

The NCDH mandates a designated swim area for all permitted beaches. At Crescent Beach, low tide is typically at least 75 yards out from the mean high-water mark. The roped off area is approximately 25 yards by 50 - 60 yards in depth.

Section 4.10 in Part 6 subpart 6-2.19 in New York State Public Health Law indicates no waste-water discharges from sewage treatment plants, combined sewers or other sources shall be permitted within 750 feet of the bathing beach. Though the drainage outfall will convey surface water, this alternative considers that the outfall would be located to meet this requirement.

A retaining wall and rock jetty belonging to Webb Institute is located east of the beach. These structures may be impacting the flow of water along the shoreline. Consequently, the outfall should be located a distance from the shore beyond the jetty.

In consideration of the three conditions noted above, the total length of the outfall pipe will be approximately 1,200 feet long. To convey 0.33 cfs, the outfall diameter will be 6-inches. For the marine environment, the proposed pipe material is high density polyethlylene (HDPE).

The inlet to the outfall would be in the area of sampling locations SW-07 and SW-10. This alternative would eliminate the dry weather flow in the creek for a distance of about 400 feet from the high tide mark. The inlet to the outfall would need to be at an elevation to provide sufficient head to convey the flow through the outfall. While there would remain tidal flow and wet weather flow in this segment of the Creek, the NYSDEC would need to approve this concept.

5.4 Operation Considerations

The beach is open seasonally. To minimize capital and operation costs, each of the three alternatives noted above could be operated beginning in mid-April before the bathing systems until the end of the bathing season.

5.5 Design Considerations

Flood Insurance Rate Map 36059C0019G indicate the potential site for the treatment system is in Zone VE (elevation 14) or Zone AE (elevation 12). The zones are subject to moderate wave action. The proposed treatment system will need to be resilient against potential flooding. A utility pole is located to the west of the end of the retaining wall on the east side of the creek. Debris indicates the base of the pole is around the high-high tide elevation (Pictures 9 and 10). Information for the NOAA tidal station in Kings Point indicates a diurnal range of 7.78 feet. The highest observed tide was 14.38 above mean low water which occurred on October 30, 2012 during Hurricane Sandy.

A review of aerial photos indicates the amount of sand along the beach shifts over time and during storm events and the route of the creek in the tidal zone shifts.

Picture 9 – Creek at High Tide

Picture 10 – Creek at Low Tide

To notify the City of abnormal conditions, a telemetry system will be installed to provide real-time monitoring data of the treatment system to City staff.

Each of the alternates requires an easement for construction and an agreement to allow site access by personnel for maintenance.

5.6 Ecological Restoration

Stormwater runoff from existing road surfaces of Cobble Court, Valley Road, and Minden Road are discharged to the ~5.8-acre tidal wetlands (on Section 31 Block 051 Lot 505) to the west of Cobble Court and/or Crescent Beach Creek with adverse impacts to water quality and ecological habitat conditions within these wetlands. Stormwater management practices identified in the 2015 New York State Stormwater Design Manual, such as stormwater wetlands or bioretention filtration systems, may be feasible alternatives for reducing the contribution of nutrients, metals, and pathogens to the adjacent wetlands and surface waters. However, these stormwater management practices would likely need to be located in existing upland areas (i.e. landward of the tidal wetland boundary) to obtain necessary environmental permits from the involved regulatory agencies (i.e. the NYSDEC, USACE, and NYSDOS) such that the proposed stormwater wetland (or other management practices) increases the area of native wetland and upland vegetation present at the existing stormwater outfall location(s). It is unlikely that the NYSDEC and other regulatory agencies would authorize the construction of a stormwater management practice within the existing tidal wetland boundary even if the tidal wetland is currently degraded and dominated by invasive plants (e.g. *Phragmites australis*) such as the wetlands to the west of Cobble Court.

Any stormwater management practice constructed in the uplands adjacent to the site's tidal wetlands should be planted with native wetland and coastal plant species. Appropriate plant species include the following:

- Upland Areas (Landward of Spring High Water):
  - Switch Grass (*Panicum virgatum*)
  - Seaside Goldenrod (*Solidago sempervirens*)
  - Groundsel Bush (*Baccharis halimifolia*)
  - Bayberry (*Morella pensylvanica*)
- At Spring High Water and Up to 1' Vertical Elevation Above SHW:
  - Marsh Elder (*Iva frutescens)*
  - Switch Grass (*Panicum virgatum*)
  - Seaside Goldenrod (*Solidago sempervirens*)
- Between Spring High Water and Mean High Water
  - Salt Hay (*Spartina patens*)
  - Salt Marsh Bulrush (*Bolboschoenus robustus*)
  - Narrow-leaved Cattail (*Typha angustifolia*)
- Below Mean High Water
  - Smooth Cordgrass (*Spartina alterniflora)*

The approximately 5.8 acre tidal wetland located to the west of Cobble Court on property owned by North Country Colony has been historically degraded due to 1) discharge of stormwater runoff and nutrient loading from the contributing watershed and 2) restriction of regular tidal exchange with Long Island Sound due to a sub-sized and potentially clogged culvert under Cobble Court. These pollutant and hydrological impacts have contributed to the proliferation of invasive Phragmites reed (Phragmites australis) within this tidal wetland and the formation of unvegetated mudflats at lower elevation portions of the marsh. Currently, only a very small area in the northeastern portion of the tidal wetland is dominated by native wetland plant species characteristic of Long Island's high and intertidal marshes such as salt hay (Spartina patens), spike grass (Distichlis spicata), and smooth cordgrass (Spartina alterniflora) with the large majority of the marsh largely dominated by invasive Phragmites australis.

Ecological conditions within this tidal wetland may be improved by either cleaning the interior of the existing pipe or installing a larger culvert under Cobble Court to 1) increase the capacity for tidal waters to enter the wetland during high tide and 2) increase the potential for tidal waters to completely drain during low tide. The location of the pipe is shown in Figure 1 and Picture 11. The increased salinity within the tidal wetland resulting from greater hydrological connectivity to the Long Island Sound and Crescent Beach Creek would likely result in some reduction of Phragmites-dominated marsh and conversion to native high marsh or native intertidal marsh communities. Increasing the capacity for this tidal wetland to drain at low tide would likely result in reduced waterlogging of marsh soils and may also contribute to an expansion of existing native high and intertidal marsh communities.

Areas requiring re-vegetation or re-planting for a culvert replacement to improve/restore ecological conditions within the tidal wetlands could be replanted utilizing the following:

- Upland Areas (Landward of Spring High Water):
  - Switch Grass (*Panicum virgatum*)
  - Seaside Goldenrod (*Solidago sempervirens*)
  - Groundsel Bush (*Baccharis halimifolia*)
  - Bayberry (*Morella pensylvanica*)
- At Spring High Water and Up to 1 Foot Vertical Elevation Above SHW:
  - Marsh Elder (*Iva frutescens)*
  - Switch Grass (*Panicum virgatum*)

- Seaside Goldenrod (*Solidago sempervirens*)
- Between Spring High Water and Mean High Water
  - Salt Hay (*Spartina patens*)
  - Spike Grass (*Distichlis spicata*)
- Between Mean High Water and Mean Tide Level
  - Smooth Cordgrass (*Spartina alterniflora*)

Picture 11 – Downstream End of Wetland Drain Pipe

United States Department of Agriculture information for each of these plants is presented in Appendix B.

5.7 Beach Management

Aerial photos indicate a sand bar has developed at Crescent Beach. The sand bar changes the circulation during tidal cycles compared to the prior uniform slope from the seawall. Erosion has appeared to reduce the width of the beach at low tide. With the retreating of the beach the adjoining rock pier may also be reducing tidal circulation. The point at which the creek discharges into Long Island Sound also shifts northward and southward along the beach. With shifting sands, ponding on the beach may also occur during low tide that causes stagnant water until the tide comes in again.

Beach sand enrichment/nourishment involves the placement of sand on a beach for the purposes of restoring it for recreational use. Restoration is generally accomplished by bringing sand to the beach from inland sites or adjoining beach segments, or by hydraulically pumping sand onshore from an offshore site.

- Insert Figure 1

The failure of restoration projects is often attributed to, among other things, a lack of appropriate and affordable material nearby. Replacement sediments may have unsuitable grain size, durability, and hydrodynamic behavior for a beach setting, and that sands derived from dredging on the adjacent shelf may contain excessive amounts of fine sand and silt too small to remain on the beach. Replacement sand should be similar (grain size, organic content) to that which was eroded, thereby maintaining the suitability of the beach.

As part of the overall remediation program, the City should collect beach sand samples for a gradation analysis so replacement sand of the same characteristics or slightly larger grain size may be obtained to restore the grade of the beach. Following beach replenishment, a topographic survey should be periodically conducted to monitor the grade of the beach in order to determine when the next sand replenishment needs to be done.

During the bathing season, the sand should be groomed regularly to eliminate depressions where standing water can accumulate.

Since the beach has not been used for swimming, the amount of waterfowl has most likely increased. Prior to opening the beach, the City should resume waterfowl population control measures that will deter primarily Canadian geese from the immediate area of Crescent Beach. Signs should also be posted to not feed waterfowl at and around the beach.

During the bathing season, debris and trash on the beach should be removed daily.

The public can walk dogs along the beach. Signs should be posted to remind people to curb their dog and to properly dispose of the waste.

6.0 ENVIRONMENTAL CONSIDERATIONS

Though an alternate has not yet been selected, a New York State Full Environmental Assessment Form has been partially completed considering siting of a treatment system located in an area at the northerly end of the creek. The purpose of completing the form was to identify potential environmental and permits that will need to be addressed during the design and construction phases of the project.

Crescent Beach is along the Long Island North Shore Heritage Area, regulated wetlands and waterbodies are on and adjacent to the site, the site is within a 100-year flood plain, and the project site is located in or adjacent to an area designated as sensitive for archaeological sites on the New York State Historic Preservation Office (SHPO) archaeological site inventory. The site is not within 2,000 feet from any site in the NYSDEC Environmental Site Remediation database.

The tidal wetlands associated with Long Island Sound/Crescent Beach, Crescent Beach Creek, and the approximately 5.8 acre tidal wetland located to west of the Cobble Court on Nassau County Tax Parcel Section 31, Block 51, Lot 509 are regulated by the New York State Department of Environmental Conservation, US Army Corps of Engineers, and New York State Department of State.

6.1 Helix System

The environmental permitting requirements for the installation of a Helix high-flow stormwater filter, manufactured by Fabco Industries, depends on the location(s) of the proposed filter unit(s). In order to minimize environmental permitting requirements and permitting feasibility, any proposed installation location for a Helix stormwater filter should be located landward of the tidal wetland boundary. Proposed stormwater filter(s) should be located within existing paved surfaces, parking areas, or mowed lawn, if possible, to minimize environmental impacts associated with disturbance to naturally vegetated areas.

NYSDEC

Helix stormwater filter construction will likely require approval from the NYSDEC, as described below. The NYSDEC requires approval under Article 25 (Tidal Wetlands) regulations for any construction, excavation/filling, or clearing of vegetation within or adjacent to the regulated tidal wetlands associated with either Crescent Beach Creek or the tidal wetlands located to the west of Cobble Court. The landward limit of the NYSDEC's Article 25 (Tidal Wetlands) jurisdiction adjacent to the wetlands at Crescent Beach, Cobble Court, and Valley Road is either 1) the 10-foot Elevation Contour (NGVD 1929) or 2) the seaward edge of an existing, functional asphalt road that was present on the effective date of the NYSDEC Tidal Wetlands regulations (August 20, 1977). As stated previously, any stormwater filter should be preferentially sited in existing paved surfaces, parking areas, or mowed lawn, if possible. If the selected stormwater filter location (and associated limits of construction activities) is landward of the 10-foot Elevation Contour (NGVD 1929) or the seaward edge of an existing, functional asphalt road that was present on the effective date on August 20, 1977, then the proposed project would quality for *Letter of No Jurisdiction* from the NYSDEC with respect to the Article 25 (Tidal Wetlands) regulations.

If the proposed stormwater filter location(s) are within the tidal wetland boundary or its adjacent area, then the construction of the stormwater filter would require an Article 25 (Tidal Wetlands) permit from the NYSDEC. If the proposed stormwater filter location requires any disturbance within or seaward of mean high-water line of any of the tidal wetlands or waterbodies, Article 15 (Protection of Waters) and 401 Water Quality Certification approvals will also be required from the NYSDEC.

USACE and NYSDOS

Approvals from the United States Army Corps of Engineers (USACE) and New York State Department of State (NYSDOS) would also be required if the proposed stormwater filter is located within the tidal wetlands or if installation of the stormwater filter requires the placement of any fill (including temporary fill) or structures (such as an outfall) within the tidal wetland boundary.

The proposed stormwater filter(s) and associated construction may be covered under a 2017 United States Army Corps of Engineers Nationwide Permit, such as Nationwide Permit #7 (Outfall Structures and Maintenance), Nationwide Permit #18 (Minor Discharges), or Nationwide Permit #43 (Stormwater Management Facilities). However, proposed stormwater filter location(s) and preliminary design are needed to determine if the project will qualify for any of these USACE Nationwide Permits. An Individual Permit from the US Army Corps of Engineers would be required under Section 404 of the Clean Water Act and Section 10 of the Rivers & Harbors Act if construction of the stormwater filter(s) requires placement of fill or structures within the tidal wetland boundary and the project does not meet the conditions of one of the above-listed Nationwide Permits.

New York State Department of State (NYSDOS) General Concurrence under the Coastal Zone Management Act is required for the installation of stormwater filter(s) if the project includes placement of any fill (including temporary fill) or structures (such as an outfall) within the tidal wetland boundary. No submission to the NYSDOS is required if project design parameters meet the requirements of USACE Nationwide Permit #18 (Minor Discharges) inclusive of New York District Permit-Specific Regional Conditions, as this Nationwide Permit has been granted conditional approval by NYSDOS. If the proposed stormwater filter construction is authorized under Nationwide Permits #7 or #43, or if an Individual Permit is required, then a Coastal Consistent Concurrence application package must be submitted to the NYSDOS Coastal Resources Division.

6.2 Ultraviolet System

The environmental permitting requirements for the installation of an Ultraviolet System are identical to that of the Helix stormwater filter and, similarly, depend on the location of the treatment unit and its associated

structural components (such as in-stream weir intake and downstream outfall). Due to the apparent necessity of in-stream structures and fill placement within the tidal wetland boundary, it is expected that the following environmental permits would be required for an Ultraviolet System:

NYSDEC

- Article 15 (Protection of Waters), Article 25 (Tidal Wetlands), and a 401 Water Quality Certification.

USACE

- Section 404 of the Clean Water Act and Section 10 of the Rivers & Harbors Act.
- Possible coverage under Nationwide Permit #7 (Outfall Structures and Maintenance), Nationwide Permit #18 (Minor Discharges), or Nationwide Permit #43 (Stormwater Management Facilities).

NYSDOS (NY State Dept. of State)

- General Concurrence under the Coastal Zone Management Act

In addition, the proposed new outfall location may require modification to the City of Glen Cove's New York State Pollutant Discharge Elimination System (SPDES) permit for stormwater discharges from its Municipal Separate Storm Sewer System (MS4). The City of Glen Cove's existing SPDES permit should be reviewed to determine if this alternative would be covered under the existing permit parameters or if modification to the SPDES permit is required.

6.3 Dry Weather Outfall

The construction of a subsurface pipe with outfall diffuser to convey dry weather surface flow from an upstream inlet location to approximately 1,200 feet offshore would require the following environmental permits. It should be noted that directional drilling of a subsurface pipe would likely require the same environmental permits to install the pipe under a regulated tidal wetland even if there is no surface disturbance within the wetland.

NYSDEC

- Article 15 (Protection of Waters), Article 25 (Tidal Wetlands), and a 401 Water Quality Certification.

USACE

- Section 404 of the Clean Water Act and Section 10 of the Rivers & Harbors Act.
- Possible coverage under Nationwide Permit #7 (Outfall Structures and Maintenance), Nationwide Permit #12 (Utility Line Activities), Nationwide Permit #18 (Minor Discharges), or Nationwide Permit #43 (Stormwater Management Facilities).

NYSDOS (NY State Dept. of State)

- General Concurrence under the Coastal Zone Management Act

In addition, the proposed new outfall pipe may require modification to the City of Glen Cove's New York State Pollutant Discharge Elimination System (SPDES) permit for stormwater discharges from its Municipal Separate Storm Sewer System (MS4). The City of Glen Cove's existing SPDES permit should be reviewed to determine if this alternative would be covered under the existing permit parameters or if modification to the SPDES permit is required.

6.4 Ecological Restoration

Environmental permitting requirements to replace and up-size the existing Cobble Court culvert include the following approvals:

NYSDEC

- Article 15 (Protection of Waters), Article 25 (Tidal Wetlands), and a 401 Water Quality Certification.

USACE

- Section 404 of the Clean Water Act and Section 10 of the Rivers & Harbors Act.
- Likely coverage under Nationwide Permit #3 (Maintenance), Nationwide Permit #18 (Minor Discharges), or Nationwide Permit #27 (Stream and Wetland Restoration Activities).

NYSDOS (NY State Dept. of State)

- General Concurrence under the Coastal Zone Management Act

6.5 Beach Management

Environmental permitting requirements for sand enrichment include the following approvals.

NYSDOS (NY State Dept. of State)

- General Concurrence under the Coastal Zone Management Act

Beach grooming is an unregulated activity.

The City of Glen Cove is a "Certified Coastal Erosion Hazard Area ("CHEA") Communities". That means that the City, not the DEC, administer the Coastal Erosion Management Permit process. DEC regulations indicate that even in Certified CEHA Communities, the DEC or other government agencies, such as Army Corps of Engineers, Department of State, or Office of General Services, may require other permits for the type or location of planned work.

DEC regulations allow a Coastal Erosion Management Permit once the DEC finds that (among other things) the proposed activity prevents, or minimizes adverse effects on...natural resources, including shellfish beds.

7.0 COST OPINION

The cost opinions are the approximation of the cost of the project as it has been defined herein this document, which may change during the design due to unanticipated conditions. The cost opinions are the product of a cost estimating process that attempts to consider the following elements:

1. Difficulty to construct the project,
2. Anticipated means and methods of qualified and competent contractors who have the prerequisite experience with the size and complexity of the project,
3. Escalation for labor and fringe benefits necessary to construct the project,
4. Insurance and cost of obtaining bonds and warranties that are in accordance with industry standards,
5. A construction schedule that considers the optimum time to gain regulatory approvals, advertise for bids, timely award and execution of the construction contract(s), and the season, weather and other site-specific conditions that impact the construction period,

6. Inflation and the economic climate (bidding environment) when the project is to be undertaken,
7. Estimated quantities and projected unit prices for items that will be incorporated into the project,
8. An approximation of the detailed design elements that are usually added during consultation with the client, regulatory agencies, and stakeholder input,
9. Direct costs for contractor general requirements, which includes such items as project management and coordination, quality control, temporary facilities and controls, cleaning and waste management.
10. Reasonable and customary indirect costs for profit, overhead and contractor contingencies are used by the bidder,
11. And an adequate contingency based on the degree of assumptions and unknowns involved with implementing the construction.

The cost opinions are predicated on the project consistently moving forward without delays that are out of the control of the designer and/or City of Glen Cove. Survey, geotechnical, and wetland delineation of the private property has not been conducted and are considered to be services that will be conducted during the design phase. The cost opinion will be further developed during preparation of bid documents of the selected alternative.

Table 3 - Cost Opinion

No.	Cost Element	Helix System	UV System	Drainage Outfall
1				
Construction Sub-total . . .				
	Engineering			
	Construction Administration			
	Construction Observation during construction			
	Engineering Sub-total . . .			
	Topographical Survey			
	Operations & Maintenance Manual			
	Legal and Bond Counsel			
	Soft Costs Sub-total . . .			
Construction + Engineering + Soft Costs Sub-total . . .				
__% Project Contingency . . .				
Total Project Cost . . .				
SAY . . .				

8.0 PROJECT SCHEDULE

The following is the proposed project schedule for implementing the recommended remediation system.

Table 4 - Project Schedule

TASK DESCRIPTION	SCHEDULE
Begin Design	, 2020
Submit Permit Applications	, 2020
Design Plans and Specifications submitted to Nassau County	, 2020
Receive regulatory review comments	, 2020
Comments received from Nassau County	, 2020
Resubmission of Design Report, Plans and Specifications to Nassau County	, 2020
Advertise for Bid	, 2020
Bid Opening for Construction Contract	, 2020
Contract Award by City	, 2020
Initiate Construction	, 2020
Complete Construction	, 2020

APPENDIX A

NYSDOH Crescent Beach Water Quality Data 2014 - 2019

CITY OF GLEN COVE
CRESCENT BEACH
DATA OF NON-COMPLIANCE

Date	Right	Center	Left
08/26/2019	270	71	56
08/20/2019	180	120	100
08/19/2019	29	74	440
08/07/2019	130	51	7
07/31/2019	160	56	43
07/30/2019	33	180	430
07/29/2019	120	180	38
07/24/2019	123	13	110
07/23/2019	280	52	150
07/02/2019	110	33	41
07/01/2019	400	46	32
06/19/2019	80	180	130
06/18/2019	100	160	1800
06/11/2019	1800	6000	5300
2019 Total Days . . .			**14**

09/20/2018	140	380	3	After season
08/13/2018	120	68	71	
08/08/2018	480	320	1600	
08/07/2018	67	74	120	
07/30/2018	13	110	56	
07/23/2018	360	240	290	
07/18/2018	6000	6000	1600	
06/18/2018	56	51	180	
06/12/2018	16	110	43	
06/04/2018	190	310	210	
2018 Total Days . . .			**10**	

09/20/2017	49	70	150	After season
09/06/2017	130	80	220	
08/23/2017	1200	1200	2200	
08/16/2017	140	230	320	
07/26/2017	48	180	160	
07/25/2017	70	80	410	
07/24/2017	2100	3300	2700	
06/27/2017	67	160	51	
06/26/2017	110	80	130	
06/20/2017	41	210	90	
05/31/2017	100	130	160	
2017 Total Days . . .			**11**	

CITY OF GLEN COVE
CRESCENT BEACH
DATA OF NON-COMPLIANCE

08/31/2016	110	70	90
08/17/2016	250	80	330
08/16/2016	230	89	26
08/03/2016	110	90	160
07/26/2016	230	240	1600
07/05/2016	66	48	160
06/08/2016	3200	220	250
06/06/2016	4600	6100	5200
06/01/2016	170	43	200
05/24/2016	290	250	400
05/18/2016	170	7	12
05/09/2016	150	210	170
05/03/2016	26	72	380
2016 Total Days . . .			**13**

07/01/2015	600	85	26
06/29/2015	310	210	280
06/22/2015	90	240	260
06/17/2015	76	140	380
06/15/2015	71	430	53
06/01/2015	56	210	42
2015 Total Days . . .			**6**

08/13/2014	9200	100	6500	
08/11/2014	60	69	140	
07/09/2014	90	210	110	
07/08/2014	180	34	20	
07/07/2014	270	70	80	
07/02/2014	1400	43	150	
06/18/2014	90	350	210	
06/16/2014	100	110	130	
06/10/2014	190	130	40	
06/09/2014	6300	4800	5500	
04/30/2014	420	520	350	Before Season
04/15/2014	80	150	1800	Before Season
2014 Total Days . . .			**12**	

Single sample marine water sample threshold
= 104/100 ml Enterococci bacteria

Not correlated with dates following rainfall
beaches may have been closed.

APPENDIX B

USDA Plant Guides

Switch Grass (*Panicum virgatum*)
Seaside Goldenrod (*Solidago sempervirens)*
Groundsel Bush (*Baccharis halimifolia)*
Bayberry (*Morella pensylvanica)*
Marsh Elder (*Iva frutescens)*
Salt Hay (*Spartina patens)*
Salt Marsh Bulrush (*Bolboschoenus robustus)*
Narrow-leaved Cattail (*Typha angustifolia)*
Spike Grass (*Distichlis spicata)*
Smooth Cordgrass (*Spartina alterniflora)*

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

SWITCHGRASS

Panicum virgatum L.

Plant Symbol = PAVI2

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
From the Southern Wetland Flora (1991)
@ plants.usda.gov

Uses

Livestock: Switchgrass is noted for its heavy growth during late spring and early summer. It provides good warm-season pasture and high quality hay for livestock.

Erosion Control: Switchgrass is perhaps our most valuable native grass on a wide range of sites. It is a valuable soil stabilization plant on strip-mine spoils, sand dunes, dikes, and other critical areas. It is also suitable for low windbreak plantings in truck crop fields.

Wildlife: Switchgrass provides excellent nesting and fall and winter cover for pheasants, quail, and rabbits. It holds up well in heavy snow (particularly 'Shelter' and 'Kanlow' cultivars) and is useful on shooting preserves. The seeds provide food for pheasants, quail, turkeys, doves, and songbirds.

Biofuel Source: Interest in switchgrass as a renewable biofuel resource has been increasing in recent years, primarily in the Southern United States. The Booneville, Arkansas, Plant Materials Center (PMC) and the Plant and Soil Science Department of Oklahoma State University (OSU) are cooperating to evaluate several upland types of switchgrass for use as a biomass energy resource. Selections of upland types of switchgrass have been evaluated by OSU for several years. The development of hybrid progeny with substantial heterosis for increased biomass yield will ultimately result in improved hybrid cultivars for the Central and Southern United States. The PMC is in the process of assessing several improved lines along with commercially available cultivars for dry-matter potential and environmental adaptation. Results of this study may contribute to producers cashing in on a growing demand for renewable fuels and a decrease on our dependency on fossil fuels.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Weediness

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use. Weed information is also available from the PLANTS Web site at plants.usda.gov.

Description

Panicum virgatum L., *s*witchgrass, is native to all of the United States except California and the Pacific Northwest. It is a perennial sod-forming grass that grows 3 to 5 feet tall and can be distinguished from other warm-season grasses, even when plants are young, by the white patch of hair at the point where the leaf attaches to the stem. The stem is round and usually has a reddish tint. The seed head is an open, spreading panicle.

Adaptation and Distributions

On suitable soils, switchgrass is climatically adapted throughout the most of the United States. Moderately deep to deep, somewhat dry to poorly drained, sandy to clay loam soils are best. It does poorly on heavy soils. In the East, it performs well on shallow and droughty soil.

Switchgrass is distributed throughout the majority of the United States, excluding the far west states. For a

current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Switchgrass should be seeded in a pure stand when used for pasture or hay because it can be managed better alone than in a mixture. Its slick, free-flowing seed can be planted with most seed drills or with a broadcast spreader. In the Southeast, a planting rate of approximately 10 pounds PLS per acre is recommended. Seedbeds should be firmed with a roller prior to the drilling or broadcasting of seed. If seeds are planted using the broadcast method, the area should be rolled afterward to help cover the seed. When drilled, seeds should be planted 1/4 inch deep. No-tillage seedings in closely grazed or burned sod also have been successful, where control of sod is accomplished with clipping, grazing, or proper herbicides.

Phosphorus and potassium should be applied according to soil tests before or at seeding. Nitrogen, however, should not be used at seeding time because it will stimulate weed growth.

Management
To control weeds during establishment, mow switchgrass to a height of 4 inches in May or 6 inches in June or July. Grazing is generally not recommended the first year, but a vigorous stand can be grazed late in the year if grazing periods are short with at least 30 days of rest provided between grazings. Switchgrass is the earliest maturing of the common native warm-season grasses and it is ready to graze in early summer.

Established stands of switchgrass may be fertilized in accordance with soil tests. Phosphorus and potassium may not be needed if the field is grazed since these elements will be recycled back to the soil by the grazing animal. Apply nitrogen after switchgrass has begun to produce using a single application in mid-to-late May or a split application in both May and early July. Avoid high rates of nitrogen because carry-over could spur cool-season grass growth and harm young plants the following spring.

Switchgrass will benefit from burning of plant residues just prior to initiation of spring growth. Burning fields once every 3 to 5 years decreases weed competition, eliminates excessive residue and stimulates switch grass growth. Switchgrass used for wildlife food and cover should be burned once every 3 to 4 years to reduce mulch accumulations that inhibit movement of hatchlings and attract nest predators.

Under continuous grazing management, begin grazing switchgrass after it has reached a height of 14 to 16 inches, and stop when plants are grazed to within 4 inches of the ground during late spring, 8 inches in early summer, and 12 inches in late summer. A rest before frost is needed to allow plants to store carbohydrates in the stem bases and crown. Plants may be grazed to a height of 6 to 8 inches after frost. The winter stubble is needed to provide insulation.

With management intensive systems, grazing can begin in the first paddocks when plants reach a height of 10 inches and should not be grazed below a stubble height of 6 to 8 inches. Grazed paddocks need to be rested 30-60 days before being grazed again.

Pests and Potential Problems
Grasshoppers and leafhoppers can be major pests in new seedings. Some stands are impacted by damping off and seedling blight. Leaf rust occasionally affects forage quality.

Cultivars, Improved, and Selected Materials (and area of origin)
'Alamo' (TX), 'Blackwell' (OK), 'Cave-In-Rock' (IL), 'Dacotah' (ND), 'Forestburg' (SD), 'Kanlow' (OK), 'Nebraska 28' (NE), 'Shawnee,' 'Shelter' (WV) (cultivars); Grenville (NM) (informal release); Miami (Dade Co, FL), Stuart (Stuart, FL), Wabasso (Wabasso, FL) (source identified releases). Seeds are available from most commercial sources and through large agricultural supply firms.

Control
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Prepared By & Species Coordinator:
USDA NRCS Plant Materials Program

Edited 16Jan2001 JLK, 28sep05 jsp, 24may06jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the

PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Read about Civil Rights at the Natural Resources Conservation Service

USDA
United States Department of Agriculture
Natural Resources Conservation Service
Plant Guide

SEASIDE GOLDENROD

Solidago sempervirens L.

Plant Symbol = SOSE

Seaside goldenrod (Solidago sempervirens L.) Photo by, William Skaradek, USDA NRCS

Alternate Names
Common Names:
salt-marsh goldenrod

Scientific Names:
Aster sempervirens (L) Kuntze;
A. mexicanus;
Solidago mexicana L.;
S. sempervirens subsp. *mexicana*;
S. sempervirens var. *Mexicana*

Description
General: Seaside goldenrod is a native, late-flowering perennial forb. It may grow up to 6 ft tall at maturity, blooming August through October. The terminal flowering heads are dense, clustered spikes of bright yellow flowers that are larger than those of other goldenrod species.

The leaves are fleshy, somewhat succulent, dark green, oblong, and lance-shaped. They are arranged alternately along the entire length of the stem. The leaves at the base are the largest, up to 8 in long and ½ –1 ½ in wide, gradually decreasing in size towards the top of the plant.

In winter, the plant's persistent whitened leaves, coarse stalks, and dried flower parts make it easily identifiable. Red leaves sprout in late February and early March, and soon become dark green. From late August to early October, its bright yellow flowers provide an attractive contrast to its lush, thick, green vegetation.

Seaside goldenrod is a short-day perennial (flowering coincides with shortened photoperiods). So that at some point as a critical dark periods lengthens, flowering is initiated. The flowers are an important food/energy source for fall migrating monarch butterflies traveling the Atlantic coastal flyway. This species can hybridize with rough-stemmed goldenrod (*Solidago rugosa*).

The fruit of the seaside goldenrod is a capsule with a pappus in a single circle of bristles. The seeds require no cold stratification for germination. When buried, seed viability decreases after the first year in both disturbed and undisturbed areas (Lee, 1993). Therefore, seaside goldenrod does not appear to have a persistent seed bank.

Transition areas (areas of greater sand movement and accumulation) tend to have greater amounts of seed in the seed bank (up to 58 seeds/m^2) when compared to grasslands (Lee, 1993). However, studies have also found germination of the plant limited to areas of minimal sand accumulation.

Distribution: Seaside goldenrod mainly grows east of the Mississippi. It grows in the northeast from Canada and the Great Lakes region, south along the Mid-Atlantic coast to Florida, and as far west as Texas. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Stands of seaside goldenrod colonize blowouts, grasslands, and transition areas. Seaside goldenrod often occurs with other native dune plants such as coastal panicgrass (*Panicum amarum*), switchgrass (*Panicum virgatum*), salt meadow cordgrass (*Spartina patens*), and American beachgrass (*Ammophila breviligulata*).

Adaptation
Seaside goldenrod can grow in coarse to medium infertile soils with a pH range from 5.5–7.5. Seaside goldenrod is well adapted to coastal habitats including the backside of primary dunes, low secondary dunes, and edges of salt marshes. It has some tolerance for drought, allowing it to survive in the dry conditions of the dunes. Seaside goldenrod is also tolerant of high salinity, salt spray, and fire.

Uses
Wildlife Use: Like many *Solidago* spp., seaside goldenrod is an important resource for over-wintering, gall-producing insects. Some of these insects are predatory wasps that are beneficial to have near crops. In addition, gall larvae provide an excellent source of nutrition in the winter for birds such as the chickadee or woodpecker. It increases the value of wildlife habitat by providing food and shelter for butterflies, birds, and small mammals. The migrating monarch butterfly uses seaside goldenrod as one of its primary food sources in the fall.

Along with American beachgrass (*Ammophila breviligulata*), seaside goldenrod plays an important role in providing nesting habitat between primary and secondary dunes for birds such as willets (*Catoptrophorus semipalmatus*), killdeer (*Charadrius vociferous*), piping plovers (*Charadrius melodus*), and black skimmers (*Rynchops niger*)(Safina and Burger, 1983).

Erosion Control: Seaside goldenrod is a native perennial that has been successfully used in dune stabilization and erosion control projects. Stems arise from short, stocky rhizomes. The root-length is a minimum of 14 in and provides excellent erosion control. Seaside goldenrod initiates dune formation by trapping sand and debris. Sites with seaside goldenrod help the secondary establishment of annual forbs such as seaside sandmat (*Euphorbia polygonifolia*), and American searocket (*Cakile edentula*) (Ailstock, n.d.).

Ethnobotany
While the medicinal value of this particular species of goldenrod remains unknown, many species in the *Solidago* genus have been used for generations as a natural remedy for a variety of health conditions (ex. *S. Canadensis* and *S. vigaurea*). Thomas Edison explored ways of using latex from the seaside goldenrod for the production of natural rubber (caoutchouc).

Status
Threatened or Endangered: No.

Wetland Indicator: FACW (Facultative Wetland). Seaside goldenrod usually occurs in wetlands, but may occur in non-wetlands.

Please consult the PLANTS Web site (http://plants.usda.gov/) and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines
Seaside goldenrod may be propagated by seed or division. Currently the only developed method of establishing seed production plots and dune restoration plantings is with containerized stock transplanted in late winter to early spring.

The first year of establishment is the most critical for survival. Once the stand is established, it requires little maintenance and only minimal irrigation due to its ability to withstand hot and dry conditions. Producers should irrigate if an extended dry period occurs. Fertilization will increase vigor of seaside goldenrod, but is not necessary for survival.

To establish, prepare a clean, weed-free seedbed. Start seeds in 2-inch deep trays, grown into vegetative plugs, planted every 2 feet in rows with 3 feet in between centers. When planting into a dune site, it is important to keep the substrate attached to the roots of the seedling to prevent desiccation (Shumway, 2008).

Growing plants with American beachgrass (*Ammophila breviligulata*) in both broadcast and seed-drilled experimental plots improves production. These nurse crops may lower temperature and increase moisture for seaside goldenrod populations. *S. sempervirens* has dehydromatricaria ester in the roots (Lam et al., 1992). This allelopathic compound is lethal to nematodes and inhibits the growth of rice seedlings.

Management
Producers often manage weeds with a pre-emergent herbicide and after establishment with mechanical cultivation. The decline in health of the closely associated American beachgrass could be used to signal when goldenrod should be fertilized.

Pests and Potential Problems
It has been reported that the release of root exudates by seaside goldenrod produce allelochemicals that negatively affect the growth of nearby vegetation. Studies by Cheplick and Aliotta (2009) found that seaside goldenrod has a negative effect on the growth of native grasses such as purple sandgrass (*Triplasis purpurea*) and sanddune sandbur (*Cenchrus tribuloides*). Being a perennial, seaside goldenrod should also have a distinct advantage over annuals when competing for limited resources. Nevertheless, because seaside goldenrod has a moderate growth rate, a shorter life span than other *Solidago* spp., a limited ability to spread through seed, and produces seedlings with low vigor, it is not considered an invasive plant.

Goldenrods in general are popular hosts to overwintering gall insects. Approximately half of all gall insects are lost to predation. Three common herbivores that feed on seaside goldenrod are the goldenrod leaf miner (*Microrhopala vittata*), red goldenrod aphid (*Uroleucon pieloui*) and the goldenrod leaf beetle (*Trirhabda Canadensis*).The goldenrod leaf miner feeds on the upper leaves, creating numerous small holes. Unlike aphids, population densities for the goldenrod leaf miner remain low and only occasionally create severe damage. The goldenrod leaf beetle is strongly attracted to the odor of the host plant *S. sempervirens*, and has been shown to prefer it to the odor of non-host plants (Puttick et al., 1988). There is no known research suggesting that *S. sempervirens* can negatively affect the growth of nearby food crops.

There is no significant herbivory recorded. Coastal or island herbivores such as rabbits and deer will occasionally browse plants in fall and winter.

Environmental Concerns
There are no environmental concerns with use of this plant.

Control
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Seeds and Plant Production
Researchers are trying to develop effective methods to grow seaside goldenrod from direct seeding in a dune setting. Seed consistently has good germination rates when grown in controlled settings such as a greenhouse or germination chamber, but stands fail to develop when directly seeded in dune trials. Currently the best way to propagate the plant is with vegetative plugs. The seed has a 3-year average of 70 % germination from 2009–2011 at the Cape May PMC, in Cape May, NJ.

Seaside goldenrod produced 75 lb/ac of seed (first year of establishment) to 220 lb/ac of seed (2 years after establishment) at the Plant Materials Center. Plants were sown 1.5 ft apart, in rows with 3.5 ft between centers. For this same population, the germination rate was 72 % after one year of storage at 40° F and 64 % after two years of storage. The plant bed was prepared with a pre-emergent herbicide and the weeds in the inter-rows were cultivated once per season.

Cold stratification and use of a light source can break dormancy and encourage germination. Seed will germinate only on the surface of sand at high temperatures. These seeds can easily dry out and die if there is no supplemental moisture or irrigation. Cross-pollination is required for viable seed. There are approximately 700,000 seeds/lb.

Cultivars, Improved, and Selected Materials (and area of origin)
Monarch Germplasm seaside goldenrod is a source-identified composite germplasm from several native populations developed by the Cape May Plant Materials Center in Cape May, NJ. Seed was collected from natural stands among the dunes of several Mid-Atlantic States: New Jersey, Delaware, and the eastern shore of Virginia. Cape May Plant Materials Center has evaluated seaside goldenrod for over ten years.

Cultivars should be selected based on the local climate, resistance to local pests, and intended use. Consult with your local land grant university, local extension or local USDA NRCS office for recommendations on adapted cultivars for use in your area.

Literature Cited

Ailstock, M.S. n.d. The in-vitro propagation of seaside goldenrod *Solidago sempervirens*. Anne Arundel Community College, Arnold, Maryland. http://images.library.wisc.edu/EcoNatRes/EFacs/Wetlands/Wetlands12/reference/econatres.wetlands12.i0010.pdf (accessed: 02 Feb. 2012)

Austin, D. F. 2004. Florida ethnobotany. CRC Press, Boca Raton, FL. p. 1075.

Cheplick, G.P., and M. Aliotta. 2009. The abundance and size of annual herbs in a coastal beach community is related to their distance from seaside goldenrod (*Solidago sempervirens*). J. Torr. Bot. Soc. 136 (1): 102-109.

Duncan, W.H., and M. B. Duncan. 1987. Seaside plants of the gulf and Atlantic coasts. Smithsonian Institution Press, Washington, D.C. p. 298.

Lam, J., L.P. Christensen, T. Farch, and T. Thomasen. 1992. Acetylenes from the roots of *Solidago* species. Phytochemistry 31(12): 4159-4161.

Lee, P.C. 1993. The effect of seed dispersal limitations on the spatial distribution of a gap species, seaside goldenrod *(Solidago sempervirens).* Can. J . Bot. 71: 978 -984.

Puttick, G.M., P.A. Morrow, and P.W. Lequesne. 1988. *Trirhabda canadensis* (Coleoptera:Chrysomelidae responses to plant odors. J. Chem. Ecol., 14 (8): 1671-1686. http://www.springerlink.com/content/u6150263v5407623/fulltext.pdf (accessed: 02 Feb. 2012)

Radford, A.E, H.E Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. The University of North Carolina Press, Chapel Hill, NC.

Safina, C., and J. Burger. 1983. Effects of human disturbance on reproductive success in the black skimmer. Condor. March-April. 85(2): 164-171.

Shumway, S.W. 2008. Atlantic seashore: beach ecology from the Gulf of Maine to Cape Hatteras. A Falcon Guide. Morris Book Publishing, LLC, China.

The University of Texas at Austin. 2012. Native plant database. Lady Bird Johnson Wildflower Center. Austin, Texas. http://www.wildflower.org/plants/result.php?id_plant=SOSE (accessed: 20 Jan. 2012)

USDA-ARS GRIN. Dr. Duke's phytochemical and ethnobotanical databases. http://www.ars-grin.gov/cgi-bin/duke/ethnobot.pl (accessed: 31 Jan. 2012)

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Sheahan, C.M. 2014. Plant Guide for seaside goldenrod *(Solidago sempervirens).* USDA-Natural Resources Conservation Service, Cape May Plant Materials Center. Cape May, 08210.

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Plant Guide

GROUNDSEL TREE

Baccharis halimifolia L.

Plant Symbol = BAHA

Contributed By: USDA NRCS National Plant Data Center & Biota of North America Program

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Botany Dept., NMNH, Smithsonian Institution
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Alternate common names
Eastern baccharis, silverling, sea myrtle, manglier, consumption weed, saltbush

Uses
The native groundsel tree is recommended as a garden shrub or hedge in Florida because of its hardiness, freedom from disease, fall flowering, and resistance to salt spray. The female plants, in particular, with their densely silver-green aspect, are beautiful when few other plants are flowering. Plants can be trained to a single trunk – tree-like and up to 10 feet tall. It is a useful shrub for reclaiming moist or wet sites, including retention areas and drainage ponds.

Although it apparently has little or no value as a good food source for game animals ("wildlife"), groundsel tree provides cover and nesting habitat for various species of birds. Bees and small butterflies use the abundant nectar from the male flowers, which in turn attract songbirds to forage on the insects.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Sunflower Family (Asteraceae). Deciduous shrubs 1-2(-6) m tall, sometimes single-stemmed from the base and tree-like. Leaves: deciduous, obovate to elliptic or narrowly elliptic-oblanceolate, 3-nerved, 2-6 cm long, smooth-margined or with 1 tooth or 1-3 pairs of coarse teeth on the upper margins, the surfaces slightly resinous, usually with small dots. Florets closely clustered in heads surrounded by involucral bracts, the heads borne in tight aggregations; heads of two sexes, each produced on a separate plant (the species dioecious) — the staminate heads (pollen-producing, with sterile ovaries) with only tubular, 5-lobed corollas; the pistillate heads (with fertile ovaries) with only thread-like corollas. Fruits ("cypselae" or achenes) are 1-seeded, nearly cylindric, 1.3-1.8 mm long, topped by a ring of numerous, slender, flexible, silvery-white bristles (the "pappus"), which elongates at achene maturity to 10-12 mm long, much longer than the involucre. The small fruits are shed with the pappus, a wind-catcher that enables fruit dispersal over a wide area. In a steady wind of about 17 km/hour, drift of seeds from a shrub two meters in height has been recorded up to 140 meters. The common name "silverling" alludes to the silvery aspect of pistillate plants in the fall, when the pappus of each maturing fruit elongates and protrudes from the head.

Variation within the species: Plants of this species from the West Indies have been called *Baccharis halimifolia* var. *angustior* DC., but there appears to be little justification for their formal recognition. *Baccharis halimifolia* closely resembles the Mexican species *Baccharis heterophylla* Kunth. Where both occur in Veracruz, Mexico, *B. halimifolia* can be

recognized by its habitats along the coast or coastal plain, its more gradate, blunt-tipped involucral bracts, and its longer pappus. Plants from central Nuevo León, Mexico, have narrower leaves than typical for *B. halimifolia*, but in most respects they are more similar to it than to *B. heterophylla*. *Baccharis halimifolia* hybridizes with *B. neglecta* Britt. where the two meet in east Texas.

Groundsel tree is a member of the sunflower family, but the sunflower-like nature of the heads is not evident without close inspection. *Baccharis halimifolia* is the species upon which the concept of the genus *Baccharis* is based (the type species).

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. Groundsel tree occurs in all states bordering the Atlantic Ocean and Gulf of Mexico, plus the Caribbean and into northeastern Mexico as far south as Veracruz and San Luis Potosí.

Establishment
Adaptation: Groundsel tree grows on beaches, marshes and hammocks near the shore, and various more inland sites, including ditches, old fields, and roadsides. Flowering in the United States occurs mainly in August-December.
General: Plants of groundsel tree as young as 3 years may produce viable seed. Because it is dioecious, male and female plants are necessary for seed production. There is no dormancy requirement for germination. Other reasons for its colonizing success are prolific seed production and high seed germination percentage, long-range seed dispersal, shade tolerant seed production, wide adaptability to soil nutrients and salinity, survival in extreme wet soil conditions, and ability to resprout after fire.

Groundsel tree can be cultivated in a sunny location. It does not tolerate heavy clay soils but can be successfully grown in nutrient-poor soil. Most native coastal plain habitats are sandy. In its resistance to salt spray, it is useful in coastal situations. It is a fast-growing plant and will quickly regrow, even if cut back to the base.

Management
Probably from initial introductions of groundsel tree as an ornamental into western Europe (France, Spain, and Italy) and Queensland, Australia, it has become an invasive weed, rapidly occupying open sites and encroaching into grassland and parkland. Because animals apparently find it unpalatable (the leaves and flowers contain a cardioactive glycoside), it is common to see the species growing in abundance in pastureland. Groundsel tree is toxic to livestock, causing staggering, trembling, convulsions, diarrhea, and other gastrointestinal symptoms, but this feature is less significant than the displacement of other vegetation through its rapid colonization. This native species has been regarded as an "infestation" on overgrazed rangeland in the southern United States.

Various native species of beetles and moths are known to feed on leaves and buds of *Baccharis*. Larvae and adults of several of these are capable of defoliating plants of groundsel tree. North American gall-forming midges, seed-feeding bugs, and stem borers also cause damage and some have been introduced into Australia as agents of biological control for *Baccharis halimifolia*.

Cultivars, Improved and Selected Materials (and area of origin)
These plant materials are somewhat available from commercial sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government". The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

References
Boldt, P.E. 1989. *Baccharis, (Asteraceae), a review of its taxonomy, phytochemistry, ecology, economic status, natural enemies and the potential for its biological control in the United States*. MP 1674, Texas Agric. Expt. Station, Texas A&M Univ., College Station, Texas.

Cronquist, A. 1980. *Vascular Flora of the Southeastern United States. Vol. 1. Asteraceae*. Univ. of North Carolina Press, Chapel Hill, North Carolina.

Nesom, G.L. 1990. *Infrageneric taxonomy of North and Central American Baccharis* (Asteraceae: Astereae). Phytologia 69:40–46.

Zanowiak, D.J. 1991. *An analysis of systematic and phyletic relationships within the Baccharidinae (Asteraceae: Astereae)*. Ph.D. Dissertation, Texas A&M University, College Station, Texas.

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NORTHERN BAYBERRY

Morella pensylvanica (Mirb.) Kartesz

Plant Symbol = MOPE6

Common Names: bayberry, candleberry, candlewood, candletree, myrique de Pennsylvanie, northern bayberry, small waxberry, swamp candleberry, tallow bayberry, tallowshrub, tallowtree, waxberry

Scientific Names: Previously known as *Myrica pensylvanica* Mirb., the currently accepted name is *Morella pensylvanica* (Mirb.) Karstesz. *Cerothamnus pensylvanica* (Mirbel) Moldenke, *Myrica cerifera* Linnaeus var. *frutescens* Castiglioni, *M. macfarlanei* Youngken

Northern bayberry (Morella pensylvanica). Photo by Scott Snell, USDA-NRCS, Plant Materials Program.

Description

General: Northern bayberry is a native perennial shrub often identified by its strongly aromatic nature. Under ideal conditions, northern bayberry may reach heights of up to 15 feet (4.5 m) and spread laterally via rhizomatous growth up to 10 feet (3 m) (Duncan and Duncan, 1987; MBG, 2017). The often multi stemmed shrub has an upright and rounded growth habit and is deciduous throughout its range, but may remain semi-evergreen at the southern extent or over mild winters throughout the rest of its range (MBG, 2017). The dark green, glossy leaves are alternately arranged and sometimes slightly toothed towards the tips measuring 2-4 in (5-10 cm) long and 0.3-0.5 in (.75-1.25 cm) wide (Silberhorn, 1999). They may be dotted with resin and are tear drop shaped tapering towards the stem. When crushed, they release a strong aromatic fragrance (MBG, 2017). The primary stems are typically light gray like the mature branches which may display a silvery hue. New growth begins green and turns tan after the initial growing season when it takes on the appearance of the more mature branches (Rhodus, n.d.). Northern bayberry is primarily a dioecious (male and female flowers on separate plants) species. Both male and female flowers are inconspicuous catkins; male flowers are yellowish green while female flowers lack both sepals and petals (Brand, 2015). Male catkins (0.4-1.8 cm) are generally longer than female catkins (0.3-1.4 cm) (Moore, 2004). The flowering period usually begins in April, but inflorescences may occur anytime between spring and early summer (Rhodus, n.d.; FNAEC, 1997). Female flowers are wind pollinated, forming clusters of single seeded drupes below leafy stem tips in the summer (Moore, 2004; Silberhorn, 1999). The immature sessile fruits are green and covered with a dense hair (Rhodus, n.d.; Duncan and Duncan, 1987). Upon maturation, the fruits develop a bluish gray color and the hairs become masked by a waxy coating (FNAEC, 1997). The fruit may range from 0.1-0.2 in (2.5-5.5 mm) in diameter (Silberhorn, 1999; Duncan and Duncan, 1987). Fruit, not consumed by wildlife, persists well into winter if (Dickerson, 2002).

Distribution: Northern bayberry is found along the Mid-Atlantic coastal region forming scattered clumps in stable dune areas. It is indigenous to the Eastern United States and Canada occurring from southern Newfoundland south to the coastal plains of North Carolina and inland as far west as Ohio (NPIN, 2013). Towards the extent of its northern range Northern bayberry may incur some damage during extremely harsh years, but can be grown in USDA hardiness zones 3a-8b (MBG, 2017; Dirr, 1998; USDA-NRCS, 2012). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

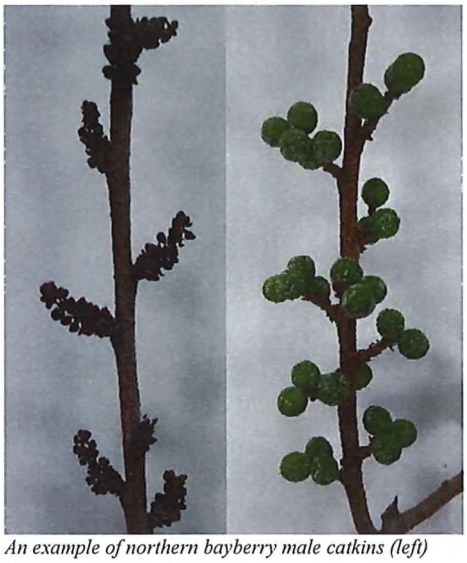
Habitat: Bayberry can grow in wide range of environments and soils, but it grows most vigorously in sandy or peaty and slightly acidic well drained soils receiving full to partial sun (MBG, 2017). Bayberry is a highly salt spray tolerant and moderately saline and drought tolerant shrub. It spreads naturally via rhizomatous growth to sandy soils free of vegetation, it is well adapted to stable dune environments and is less frequently found scattered throughout the primary dunes of the Mid-Atlantic region (Gilman and Watson, 1994; Dickerson, 2002). Near the coast in the dune environment it is often associated with American beachgrass (*Ammophila breviligulata*), seaside goldenrod (*Solidago sempervirens*), eastern poison ivy (*Toxicodendron radicans*), roundleaf greenbriar (*Smilax rotundifolia*), Virginia creeper (*Parthenocissus quinquefolia*), beach plum (*Prunus maritima*), black cherry (*Prunus serotina*), eastern red cedar (*Juniperus virginiana*), rugosa rose (*Rosa rugosa*), and winged sumac (*Rhus copallinum*) (Martin, 1959). Although typically considered a dune plant, northern bayberry also occurs inland thriving in fallow or abandoned agricultural land, along the borders of woodlands, pine barrens, marshes, swamps, and ponds (Duncan and Duncan, 1987; Stalter, 1992). In habitats outside of the dune environment northern bayberry often occurs with saltgrass (*Distichlis spicata*), red maple (*Acer rubrum*), eastern baccharis (*Baccharis halimifolia*), switchgrass (*Panicum virgatum*), and little bluestem (*Schizachyrium scoparium*) (Martin, 1959). Bayberry may also occur in areas completely lacking topsoil such as mined sites, edges of railroads, and roadway cuts (Fordham, 1983). Because it may occur as frequently in wetlands as in non-wetlands, northern bayberry has been assigned a wetland indicator status of facultative for all wetland regions in which it occurs (USACE, 2018).

Adaptation: The genus *Morella* is the largest of the Myricaceae family composed of roughly 50 species distributed widely in North America, Europe, Africa, and Asia (Benson, 2018). Difficulties and some disagreement have arisen regarding the taxonomy of the *Morella* and *Myrica* genera within the Myricaceae family which has resulted in many species (including northern bayberry) being renamed to the *Morella* genus after having been formerly named as a member of the *Myrica* genus (Parra-O, 2002). Further complicating the matter, some taxonomists disagree as to whether northern bayberry and southern bayberry (*Morella caroliniensis*) should be classified as distinct, separate species. Wilbur (2002) claimed that the characteristics used to differentiate the two "seem to be more like tendencies than sharply delineated differences." This plant guide will regard northern bayberry as a distinct and unique species. Northern bayberry has a high tolerance for salt spray and low water availability making it well adapted to the coastal dune environment. Greenhouse and field studies have shown that bayberry incurs little to no damage from salt spray (Griffiths et al., 2003). Northern bayberry is well adapted to nitrogen poor soils because of a symbiotic relationship between bayberry and the nitrogen fixing bacteria Frankia (Bloom et al., 1989). Fimbel and Kuser (1995) reported that bayberry is estimated to add 15 to 28 lbs per acre of available nitrogen per year to sand dunes of the Mid-Atlantic US. The majority of research on bayberry has focused on the coastal dune environment where the chance for fire is low, limiting information on the effect fire has on the species (Hauser, 2006). Environmental conditions and timing of the burn treatments likely affect the response of bayberry to fire. Dunwiddie (1998) reported a significant decrease in the frequency and coverage of bayberry following spring and summer burn treatments in sandplain grasslands and coastal heathlands of Massachusetts. October burn treatments resulted in increased or unchanged frequency and coverage suggesting that bayberry is more susceptible to fire damage while actively growing but tolerant if burned while dormant.

Uses

Conservation practices: The adaptations that give bayberry its drought tolerance and ability to endure salt spray and saline soils also make it an excellent species to be used for stabilization of coastal sand dunes of the Mid-Atlantic region (Dickerson, 2002). Bayberry is an important successional species that colonizes landward expansion of the dune system beyond the foredune encouraging the recruitment and growth of other woody and vining species to form dense shrub thickets which provide long term stabilization (Wooton et al., 2016; Tiffney and Barrera, 1979). Bayberry may also improve the overall health of the ecosystem by providing microclimates that are beneficial for other native dune plant species. Shumway (2000) reported that both seaside goldenrod and American beachgrass plants displayed increased health and vigor when growing in association with bayberry, including, increased flowering, numbers of flowers, seed produced, plant size, tissue nitrogen concentrations, photosynthetic efficiencies, and mid-day xylem water potentials. Shumway (2000) attributed the improved plant performance of the companion species to the microclimate created by the canopy and increased nitrogen levels beneath bayberry thickets. Shumway and Banks (2001) also reported that bayberry is a valuable constituent of the plant communities that populate the waterlogged soils of interdunal swales, growing best in the drier swales and at the perimeters of the more frequently flooded swales.

Ornamental/landscaping: The showiness of the persistent winter fruit has made bayberry valuable as a landscape plant. Its value is increased by its versatility, survivability, and durability. Bayberry may be used in woodland gardens, privacy



An example of northern bayberry male catkins (left) and immature female fruit (right).

screens, garden shrub borders, along roadways, in parking lots or above ground planters (Gilman and Watson, 1994; MBG, 2017). There are several bayberry varieties resistant to disease and insects with improved growth form, foliage abundance, vigor, and survival. Its salt tolerance makes it an ideal choice for sites receiving regular salt applications such as roadsides and parking lots. Gilman and Watson (1994) warn that when used along roadsides plants should be set back from the roadway as unpruned branches tend to droop and may impede traffic.

Wildlife: Winter persistent fruit and late season leaf retention make bayberry valuable food and shelter for wildlife. The fruit is typically above snow accumulations and available throughout the winter to bobwhite quail, ruffed grouse, turkey, ring-necked pheasant, woodpeckers and numerous songbirds (Dickerson, 2002; Chatfield, 2016). Yellow-rumped warblers (*Setophaga coronate*) and tree swallows (*Tachycineta bicolor*) feed regularly on the waxy fruits from autumn through winter and into the spring (Place and Stiles, 1992). The yellow-rumped warbler may subsist primarily on bayberry fruit at certain stopover sites during fall migration (Podlesak et al., 2005). One hundred percent of the 65 specimens of tree swallows dissected during a vegetation management study at John F. Kennedy International Airport contained bayberry fruit. The removal of bayberry shrubs around the airport resulted in a 75 percent decrease in swallow aircraft strikes (Bernhardt et al., 2009). Fecal seed traps reveal that bayberry fruit becomes an important food source for insectivorous birds along the Mid-Atlantic coast during migration, during winter months Morella spp. [bayberry and wax myrtle (*M. cerifera*)] accounted for 99 percent of all seeds collected (Shiftett and Young, 2010). In Massachusetts, bayberry contributes valuable habitat for the rare northern harrier (*Circus hudsonius*), two harrier pairs establish territory and roost at Barney's Joy Point in dense thickets of northern bayberry (Christiansen and Reinert, 1990). Bayberry also attracts squirrels and other small mammals and is an important food source for some larger mammals (Gilman and Watson, 1994). Bayberry and wax myrtle on Assateague Island, MD are an important food source for of sika (*Cervus nippon*) and white-tailed deer (*Odocoileus virginianus*) (Keiper, 1985). Bayberry also provides food and shelter for beneficial insects. A review of honey bee forage literature ranking the nectar and pollen source of wild flowering plant species, ranked bayberry as a minor source for both nectar and pollen (Loose et al., 2005). Loose (2000) also reported that the leafcutter bee (*Megachile addenda*) uses bayberry leaves as a nest building material. Bayberry is a known larval host plant for Columbia silkmoth (*Hyalophora columbia*) (NPIN, 2013).

Ethnobotany

Warning: The wax from bayberry fruit is considered toxic and may be carcinogenic.

Early American settlers used the waxy coating of bayberry fruit to produce highly valuable scented candles that did not sputter or smoke. The candles were labor intensive with each 2 ounce candle requiring 5-10 thousand fruits. The blue green water produced after simmering the wax off the fruit was used to dye homespun cloth (Connor, 1993). The plant materials strong aroma made it attractive for use in the production of sealing wax and soaps (MBG, 2017). Many of the traditional items produced from bayberry fruit by early settlers remain popular today as decorative and useful household items (Bornstein, 1997). Bayberry bark was used as a paste or powder to improve oral hygiene and as an ingredient in mouthwashes to treat canker sores and soft gums (Lewis, 1977 and Orr, 2014). Morella spp. were used by various Native American tribes to induce vomiting, treat menstrual problems, purify blood and a kidney aid (Moerman, 1986). The Mi'kmaq used leaf snuff to treat headaches, tea from the leaves as a stimulant, and root bark as a poultice to reduce inflammation (Foster and Duke, 2000). Myricitrin, a strong antioxidant, is found in bayberry bark and is separated and purified using high speed counter current chromatography. Myricitrin is used in food, pharmaceutical, and cosmetic products (Orr, 2014 and Fu et al., 2013). Myricitrin has anti-inflammatory, antimutagenic, diuretic, and antibacterial properties (Foster and Duke, 2000).

Status

Threatened or Endangered: Bayberry is considered exploitable/vulnerable in New York and endangered in Ohio (USDA-NRCS, 2018).

Wetland Indicator: FAC (USACE, 2018).

Weedy or Invasive: Bayberry may spread aggressively via rhizomatous growth and display allelopathic effects (Collins and Quinn, 1982).

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use.

Please consult the PLANTS Web site (http://plants.usda.gov/) and your state's Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines

One to two year old bare root or containerized plants are recommended for all purposes. Existing vegetation should be controlled prior to planting as bayberry does not compete well with established vegetation. Bayberry shrubs planted in weed free (plowed and harrowed) sites have significantly higher survival rate than shrubs planted in untreated sites (Cook and Edminster, 1944). Adding mulch to a newly installed planting provides additional moisture retention and weed control (Dickerson, 2002). Fertilizer is not recommended, as the additional nutrients may encourage weed growth and increase weed competition. The preferred soil pH is 6.0-6.5 (USDA-NRCS, 2012). Any soil amendments should be based on the results of soil nutrient analysis tests. Consult your local agricultural extension service for guidance. Plant spacing is variable and based on site conditions and planting purpose. General guidelines for dune plantings are to plant in groupings with plants two to three feet apart. Border and hedge row plantings are planted as one or two rows of plants with three to four feet between plants. A single row planted at the same spacing is sufficient for roadway plantings (Dickerson, 2002; MBG, 2017; USDA-NRCS, 2012). If fruit production is desirable for ornamental, wildlife benefits, or other purposes; male and female plants must be planted near one another to achieve successfully pollination. For a good fruit set, it is recommended that 20 percent of the shrubs planted should be male (Brand, 2015). Sex of seedlings cannot be determined until the plant reaches maturity (three to four years), where seed production is a high priority it is best to purchase commercially available sexed varieties.

Management

Plantings installed in natural areas, dune construction sites or revegetation sites require no follow up maintenance. Other applications may require maintenance depending on site conditions and the purpose of the planting. Bayberry may need regular maintenance if planted close to the road to prevent drooping branches can hang low impeding traffic flow. Gilman and Watson (1994) recommend setting the shrubs far enough back from the road to avoid the issue or regular pruning. They recommend heading the top of the shrubs twice a year to prevent lanky branches which tend to sag. Heavy pruning is generally discouraged as it may reduce plant vigor and result in die back (Dickerson, 2002; USDA-NRCS, 2012).

Pests and Potential Problems

No significant problems with pests or diseases of northern bayberry have been documented (Gilman and Watson, 1994).

Environmental Concerns

Encroachment by bayberry may reduce or displace native coastal grasslands dominated by little bluestem (*Schizachyrium scoparium*). This shift is attributed to litter accumulation, shading, and the vigorous vegetative spread of northern bayberry (Collins and Quinn, 1982; Rogers, et al., 1985). Collins and Quinn (1982) suggest that bayberry may display allelopathic effects that contribute to the displacement of little bluestem.

Control

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Prescribed burn treatments implemented while bayberry is actively growing reduce frequency and coverage. Mow treatments reduce frequency and coverage if performed while bayberry is actively growing, dormant mowing had little or no effect (Dunwiddie, 1998). Areas browsed by domestic sheep have also shown significantly reduced frequency and coverage compared to unbrowsed areas (Dunwiddie,1997).

Seeds and Plant Production

Bayberry shrubs may be started vegetatively or from seed. Vegetative propagation is achieved by cuttings or division of suckering plants (Brand, 2015). Semi-hardwood cuttings root moderately well with a hormone treatment (NPIN, 2013). Dirr (1998) reported some rooting success by taking cuttings in mid-June and treating with indole-3-butyric acid (IBA). Cuttings treated with 0 or 1000 ppm IBA failed to root. Cuttings treated with 2500, 5000, or 10000 ppm IBA rooted at 36, 53, and 46 percent.

Seed is hand harvested in the fall from September to October. Seed is stored in cold (4.4°C) dry conditions with the waxy coating remaining on the fruit. When the seed is ready to be planted, remove the waxy coating from the fruit to increase germination rates (Fordham, 1983). The waxy coat may be removed by physical agitation or for small lots a simple rubbing board. Larger lots can be processed efficiently using a brush machine with stiff bristles and a 7/64 in (2.8 mm) square mesh mantle. Chaff should be separated from the seed prior to storage. Seed can be quickly cleaned using an air/screen separator with a 12/64 in (4.76 mm) top screen and a 1/12 in (2.12 mm) bottom screen. Higher purity can be achieved by further cleaning with a continuous blowing separator or a spiral separator. There are approximately 55,000 seeds/lb (Dirr, 1998; Van der Grinten, 2007).

Bayberry seed requires a cold moist stratification period to break dormancy. A 90 day stratification at 1.1-4.4°C is recommended (Van der Grinten, 2007). This can be achieved by fall sowing outdoors or placing in a temperature controlled environment for the duration of the stratification period. If stratifying the seed in a controlled environment, seed should be mixed with a medium such as damp sand, sphagnum moss, or peat moss to retain moisture (Fordham, 1983). For outdoor seed stratification fall seeded raised beds are recommended, Clean, weed free seed beds should be seeded at a rate of four grams of pure live seed per square foot after the soil temperature is below 4.4°C (Dickerson, 2002). Seed should be packed with a roller after broadcasting to ensure good seed to soil contact. Seed should then be covered with a 1-1.5 in (2.5-3.8 cm) layer of clean sand followed by a layer of weed free mulch such as salt hay (*Spartina patens*). The mulch should be removed in early spring prior to seedling emergence. Consider weed control options as necessary to increase vigor of the bayberry seedlings. Seedlings should be harvested after one growing season in the fall or spring while dormant (Fournier, 1993).

It is important to note that northern bayberry easily hybridizes with both wax myrtle and southern bayberry where these species' ranges overlap (FNAEC, 1997). All three species are wind pollinated requiring a seed production location with an adequate distance between species to avoid unintentional hybridization. Lorenz et al. (1991) reported that bayberry shrubs will not produce seed until after two to three growing seasons. The bayberry seed production plot at the Cape May Plant Materials Center was planted in 2002 and consists of 34% female shrubs. The production plot has yielded an average annual production of 5.4 lbs of cleaned seed per female shrub from 2010-2015.

Cultivars, Improved, and Selected Materials (and area of origin)

Some nurseries offer sexed selections of northern bayberry that are readily available:

1. 'Bobzam', commonly sold as Bobbee, is a selection developed by Lake County Nursery. Bobzam is a female clone selected as a more compact shrub and for its leaves that are larger, glossier, and more wavy than wild bayberry shrubs (Chatfield, 2016).
2. 'Morton' Silver Sprite (IL) is a female clone selected for a more compact growth pattern than is common for wild bayberry with the parent plant measuring only 5 ft tall after 15 growing seasons. 'Morton Male' Silver Sprite (IL) is the male clone counterpart to provide pollination for Morton. Morton Male also displays a relatively compact growth habit and the two cultivars' flower periods coincide to increase the likelihood of successful pollination and good fruit production (Ault, n.d.).
3. 'Myda' and 'Myriman' are sometimes available. Myda is a female clone selected for higher fruit production and Myriman is the male counterpart clone for pollination.
4. 'Northern Girl' is a female cultivar selected for heavy fruit set (Ogren, 2015). Northern Girl is not readily available commercially.
5. 'Wildwood' (NJ and NC) is a non-sexed, somewhat commercially available cultivar developed and released by the Cape May Plant Materials Center, USDA-NRCS in 1993. Wildwood is a cross of four wild collections that exhibited superior disease and insect resistance, seedling vigor, survival rate, and foliage abundance (USDA-NRCS, 2012).

Cultivars should be selected based on the local climate, resistance to local pests, and intended use. Consult with your local land grant university, local extension or local USDA NRCS office for recommendations on adapted cultivars for use in your area.

Literature Cited

Ault, J. n.d. Chicagoland Grows Plant Introduction Program. [Online]. Available at http://www.chicagolandgrows.org/shrubs/bayberry.php (accessed 30 July 2018). Chicago Botanic Garden, Chicago IL. The Morton Arboretum, Lisle, IL.

Benson, D.R. 2018. Frankia and Actinorhizal plant Website. [Online]. Available at http://web.uconn.edu/mcbstaff/benson/Frankia/Myricaceae.htm (accessed 12 October 2018). University of Connecticut, Storrs, CT.

Bernhardt, G.E, Z.J. Patton, L.A. Kutschback-Brohl, and R.A. Dolbeer. 2009. Management of bayberry in relation to tree-swallow strikes at John F. Kennedy International Airport, New York. Human-Wildlife conflicts 3(2): 237-241.

Bloom, R.A., M.P. Lechevalier, and R.L. Tate III. 1989. Physiological, chemical, morphological, and plant infectivity characteristics of Frankia isolates from Myrica pensylvanica: correlation to DNA restriction patterns. Appl. Environ. Microbiol. 55(9): 2161-2166.

Bornstein, A.J. 1997. Myricaceae. In: Flora of North America Editorial Committee, eds. Flora of North America. Vol. 3. Oxford University Press, New York. p. 430-434.

Brand, M.H. 2015. Myrica pensylvanica, Northern Bayberry, Candleberry [Online]. Available at http://www.hort.uconn.edu/plants/detail.php?pid=292 (accessed 7 August 2018). Univ. of Connecticut Plant Database, Dept. of Plant Science and Landscape Architecture, Storrs, CT.

Chatfield, H. 2016. Shrub of the Week: Northern Bayberry. [Online]. Available at https://bygl.osu.edu/node/554 (accessed 30 July 2018). Buckeye yard & Garden online, College of Food, Agricultural, and Environmental Sciences, Ohio State Univ. Extension, Columbus, OH.

Christian, D.A. and S.E. Reinert. 1990. Habitat use of the northern harrier in a coastal Massachusetts shrubland with notes on population trends in southeastern New England. J. Raptor Re. 24(4): 84-90.

Collins, B.S. and J. A. Quinn. 1982. Displacement of *Andropogon scoparius* on the New Jersey Piedmont by the successional shrub Myrica pensylvanica. Am. J. Bot. 69(5): 680-689.

Connor, S. 1993. New England natives: A celebration of people and trees. Harvard University Press, Cambridge, MA.

Cook, E.B. and F.C. Edminster. 1944. Survival and growth of shrubs planted for wildlife in New York. J. Wildl. Manage. 8(3): 185-191.

Dickerson, J. 2002. Plant fact sheet for *Morella pensylvanica*, bayberry. USDA-Natural Resources Conservation Service, New York State Office, Syracuse, NY.

Dirr, M.A., 1998. Manual of woody landscape plants. Stipes Publishing, Champaign, IL.

Duncan, W.H. and M.B. Duncan. 1987. The Smithsonian guide to seaside plants of the Gulf and Atlantic coasts. Smithsonian Institution Press. Washington, D.C.

Dunwiddie, P.W. 1997. Long-term effects of sheep grazing on coastal sandplain vegetation. Nat. Areas J. 17(3): 261-264.

Dunwiddie, P.W. 1998. Ecological management of sandplain grasslands and coastal heathlands in southeastern Massachusetts. In: Pruden, Teresa L.; Brennan, Leonard A., eds. Fire in ecosystem management: shifting the paradigm from suppression to prescription: Proceedings, Tall Timbers fire ecology conference; 1996 May 7-10; Boise, ID. No. 20. Tallahassee, FL: Tall Timbers Research Station: 83-93.

FNAEC (Flora of North America Editorial Committee). 1997. Flora of North America Volume 3. [Online]. Available at http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233500794 (accessed 2 Aug. 2018). Flora of North America Association.

Fimbel, R.A. and J.E. Kuser. 1995. Competitive and mutualistic interactions between pitch pine, bayberry, and their symbionts. Soil Sci. 160(1): 69-76.

Fordham, A.J. 1983. Of birds and bayberries: seed dispersal and propagation of three *Myrica* species. Arnoldia. 43(4): 20-23.

Foster, S. and J.A. Duke. 2000. Eastern/Central medicinal plants and herbs. Houghton Mifflin Company, Boston.

Fournier, M. 1993. Commercial Production Procedure for 'Wildwood' bayberry (*Myrica pensylvanica*), 'Ocean View' beach plum (*Prunus maritima*), and 'Sandy' rugosa rose (*Rosa rugosa*). USDA-Natural Resources Conservation Service, Cape May Plant Materials Center. Cape May, NJ.

Fu, Y., Z. Li, J. Si, Q. Chang, Z. Li, and R. Pan. 2013. Separation and purification of myricitrin from bayberry tree bark by high-speed counter-current chromatography. J. of Liquid Chromatography & Related Technologies 36(11): 1503-1512.

Gilman, E.F. and D.G. Watson. 1994. *Myrica pensylvanica* Northern Bayberry Fact Sheet ST-411. U.S. Department of Agriculture, Forest Service.

Griffiths, M.E. and C.O. Orians. 2003. Responses of common and successional heathland species to manipulated salt spray and water availability. Am. J. Bot. 90(12): 1720-1728.

Griffiths, M.E. and C.O. Orians. 2003. Salt spray differentially affects water status, necrosis, and growth in coastal sandplain heathland species. Am. J. Bot. 90(8): 1188-1196.

Hauser, A.S. 2006. Morella pensylvanica. In: Fire Effects Information System, [Online]. Available at https://www.fs.fed.us/database/feis/plants/shrub/morpen/all.html (accessed 15 October 2018). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Keiper, R.R. 1985. Are sika deer responsible for the decline of white-tailed deer on Assateague Island, Maryland? Wildl. Soc. Bull. 13: 144-146.

Lewis, W.H. 1977. Medical botany. John Wiley & Sons, New York. 515 p.

Loose, J.L. 2000. The relationships between native bee communities and floral resources in Massachusetts cranberry bogs. M.S. thesis, University of Maine, Orono.

Loose, J.L., F.A. Drummond, C. Stubbs, S. Woods, and S. Hoffman. 2005. Conservation and management of native bees in cranberry. Maine Agricultural and Forest Experiment Station Technical Bulletin 191. University of Maine, Orono.

Lorenz, D.G., W.C. Sharp, and J.D. Ruffner. 1991. Conservation plants for the Northeast. Program Aid 1154. USDA - Soil Conservation Service, Washington, DC.

MBG (Missouri Botanical Garden). 2017. Gardening Help – *Myrica pensylvanica*. [Online]. Available at http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=e310 (accessed 7 Aug. 2018). Missouri Botanical Garden, St. Louis, MO.

Martin, W.E. 1959. The vegetation of Island Beach State Park. Ecological Monographs 29(1): 2-46.

Moerman, D.E. 1986. Medicinal plants of Native America. 2 Vols. Technical Report 19. University of Michigan Museum of Anthropology, Ann Arbor, MI. 910 p.

Moore, G. 2004. *Morella caroliniensis*. In: Francis, John K., ed. Wildland shrubs of the United States and its territories: thamnic descriptions: volume 1. Gen. Tech. Rep. IITF-GTR-26. San Juan, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry; Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 502-504.

NPIN (Native Plant Information Network). 2013. *Morella pensylvanica*. [Online]. Available at https://www.wildflower.org/plants/result.php?id_plant=mope6 (accessed 07 September 2018). Lady Bird Johnson Wildflower Center. The Univ. of Texas at Austin.

Ogren, T.L. 2015. The allergy-fighting garden: stop asthma and allergies with smart landscaping. Ten Speed Press, New York.

Orr, S. 2014. The new American herbal. Crown Publishing Group, New York.

Parra-O, C. 2002. New combinations in South American Myricaceae. Brittonia 54(4): 322-326.

Place, A.R. and E.W. Stiles. 1992. Living off the wax of the land: Bayberries and yellow-rumped warblers. The Auk 109(2): 334-345.

Podlesak, D.W., S.R. McWilliams, and K.A. Hatch. 2005. Stable isotopes in breath, blood, feces and feathers can indicate intra-individual changes in the diet of migratory songbirds. Oecologia 142: 501-510.

Rhodus, T. n.d. Ohio State Pocket Gardner. [Online]. Available at https://hvp.osu.edu/pocketgardener/source/description/my_anica.html (accessed 7 Aug. 2018). College of food, agricultural, and environmental sciences, OH State Univ. Columbus, OH.

Rogers, G.F., J.M. Robertson, W.D. Solecki, and M.K. Vint. 1985. Rate of *Myrica pensylvanica* (bayberry) expansion in grassland at Gateway National Recreation Area, New York. Bulletin of the Torrey Botanical Club. 112(1): 74-78.

Shiflett, SA. and D.R. Young. 2010. Avian seed dispersal on Virginia barrier islands: Potential influence on vegetation community structure and patch dynamics. Am. Midl. Nat. 164(1): 91-106.

Shumway, S.W. 2000. Facilitative effects of a sand dune shrub on species growing beneath the shrub canopy. Oecologia 124: 138-148.

Shumway, S.W. and C.R. Banks. 2001. Species distributions in interdunal swale communities: The effects of soil waterlogging. Am. Midl. Nat. 145: 137-146.

Silberhorn, G.M. 1999. Common plants of the Mid-Atlantic coast. The Johns Hopkins Univ. Press, Baltimore, MD.

Stalter, R. 1992. Barrier island botany. Wm. C. Brown Publishers, Dubuque, IA.

Tiffney, W.N., Jr. and J.F. Barrera. 1979. Comparative growth of pitch and Japanese black pine in clumps of the N2-fixing shrub, bayberry. Bot. Gaz. 140(Supplement): S108-S109.

US Army Corps of Engineers (USACE). 2018. National Wetland Plant List v3.3 – Species Detail Tool. [Online]. Available at http://wetland-plants.usace.army.mil/nwpl_static/v33/species/species.html?DET=001100 (accessed 11 Oct. 2018). USDOD-Army Corps of Engineers. Washington, DC.

USDA-NRCS. 2012. Release brochure for bayberry 'Wildwood' (*Morella pensylvanica*). USDA-Natural Resources Conservation Service, Cape May Plant Materials Center. Cape May, NJ.

USDA-NRCS. 2018. Plants Database – *Morella pensylvanica* (Mirb.) Kartesz northern bayberry. [Online]. Available at https://plants.usda.gov/core/profile?symbol=mope6 (accessed 16 October 2018). USDA-Natural Resources Conservation Service.

Wilbur, R.L. 2002. The identity and history of *Myrica caroliniensis* (Myricaceae). Rhodora 104(917): 31-41.

Wootton, L., J. Miller, C. Miller, M. Piik, A. Williams, and P. Rowe. 2016. Dune Manual. New Jersey Sea Grant consortium.

Van der Grinten, M. 2007. Propagation protocol for production of Container (plug) *Morella pensylvanica* Lionel plants. [Online]. Available at https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=myricaceae-morella-1000&referer=wildflower (accessed 11 Oct. 2018). Native Plant Network, US Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources.

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Plant Fact Sheet

MARSH ELDER

Iva frutescens L.

Plant Symbol = IVFR

Contributed by: USDA NRCS New Jersey State Office & Cape May Plant Materials Center

Robert H Mohlenbrock
USDA NRCS 1991
Southern Wetland Flora
@USDA NRCS PLANTS

Alternate Names
High-tide bush

Uses
The marsh elder is normally associated with the mid to high marsh ecosystem, forming the last line of defense for shoreline erosion control. More recently this species has become associated with the lower marsh system by colonizing the dredged material resulting from construction of ditches and ponds for mosquito control.

Habitat: During extreme high tides, both small mammals and birds have been reported to use emergent vegetation as island of refuge. The marsh elder would readily serve this purpose. Marsh elder also provides suitable nesting habitats for various species of birds, like the red-winged blackbird and the marsh wren.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Marsh elder is a perennial, deciduous shrub commonly growing between 3-8 feet high. The succulent leaves are egg-shaped to narrowly lance-shaped and oppositely arranged except for the upper reduced leaves. The lower leaves grow 4-6 inches long and 1-2 inches wide. Many greenish-white flower heads are arranged on terminal stems subtended by tiny green, leaf-like appendages. It is often confused with groundsel (*Baccharis halimifolia*) which exhibits succulent, coarsely-toothed leaves alternately arranged on the stem.

Adaptation and Distribution
The marsh elder naturally grows in the mid to high salt marsh-estuarine area, back dunes, and on muddy sea shores from Massachusetts to Florida and Texas. Here it commonly occurs with groundsel tree to form the salt bush community. These plants usually only occur at elevations where their roots are not subject to prolonged water table flooding, such as the upland border of salt marshes. However, there are occasional exceptions where these associated plants are found at lower elevations associated with drainage ditches and canals.

For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Marsh elder is generally established as 1 to 2 year old containerized plants, however 1 year bare root seedlings have been transplanted successfully in the spring. Since this plant has the ability to root from a dormant, unrooted cutting it may have application in soil bioengineering systems for tidal shoreline stabilization.

Management
No specific management recommended.

Pests and Potential Problems
None.

Environmental Concerns
None.

Cultivars, Improved, and Selected Materials (and area of origin)
Plants are commercially available from specialized coastal and wetland plant nurseries.

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Edited: 05Feb2002 JLK, 060801 jsp

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Plant Guide

SALTMEADOW CORDGRASS

Spartina patens (Aiton) Muhl.

Plant Symbol = SPPA

USDA NRCS National Plant Materials Center
Beltsville, MD

Contributed by: USDA NRCS Rose Lake Plant Materials Center.

Alternate Names
Marshhay cordgrass

Uses
Saltmeadow cordgrass is used for shoreline protection and tidal marsh restorations, and is often utilized for levee stabilization and dune stabilization plantings near coastal beaches and on barrier islands. It is an important species for dissipating wave energy in low topography relief coastlines (Stallins, 2002). Saltmeadow cordgrass is an effective stabilizer used on interior mud flats, dredge fill sites, and other areas of loose and unconsolidated soils associated with marsh restoration (Burger and Shisler, 1983). However, saltmeadow cordgrass colonies can be barried and killed by sand accumulation of 3 feet or more (Courtemanche et al., 1999). Saltmeadow cordgrass has been observed to inhibit the spread of aggressive rhizomatous species. Encroachment of *Phragmites australis* was blocked by saltmeadow cordgrass in restored marshes in New Jersey (Wang et al., 2006). Saltmeadow cordgrass may play an important role for remediating and restoring marshes after oil spills. Saltmeadow cordgrass dominated coastal wetlands are predicted to recover from oil spills without additional intervention procedures (DeLaune et al., 2003).
Saltmeadow cordgrass also provides food and cover to many terrestrial and aquatic species of wildlife including muskrats, nutria, rabbits, ducks, white-footed mouse and meadow vole (Stutzenbaker, 1999; Abuzeineh et al., 2007). In Canada, saltmeadow cordgrass is known to be a larval host of the endangered maritime ringlet butterfly (Sei, 2009). Saltmeadow cordgrass is considered an important forage species to livestock producers along the gulf coast (Stutzenbaker, 1999) and is cut and dried for hay in New England and Newfoundland (Stalter, 2003). This species is the primary component of salt hay, which is utilized in the landscape and vegetable trade industry as weed seed free mulch.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Weediness
This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. It is considered an invasive plant in Washington and Oregon (Washington Administrative Code, 2005; Oregon Dept. of Agriculture, 2006). Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use. Weed information is also available from the PLANTS Web site at plants.usda.gov.

Description
This warm season, native, perennial grows from 1 to 4 feet tall, and spreads extensively by long slender rhizomes. Dark green stems emerge from the rhizomes. The rolled leaf blades are typically 1/2 to 1 foot long, and 0.1 to 0.2 inches wide. Leaf blades are shiny, dark green on the upper surface and rough with prominent veins on the lower surface. Leaves are drooping and wiry in appearance. From late June to October an inflorescence emerges at the end of the stem, which is composed of 2 to 10 two-inch-long spikelets. The numerous florets are 0.3 to 0.4 inches long and arranged in an overlapping scale-like fashion on each spikelet. The flowers are wind pollinated and self-sterile (Barkworth, 2003; Gould, 1975).

Distribution:
Saltmarsh cordgrass has been observed from the Atlantic shorelines in Newfoundland, Canada to the coastlines of Florida and Texas and as far south as Quintana Roo in Mexico (Stalter, 1993; Gould, 1975; Sauer, 1967). Saltmarsh cordgrass has also been observed along Lake Huron in Michigan (Voss, 1972). It also occurs in Oregon and Washington where it is considered invasive. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Saltmeadow cordgrass is commonly found growing in saline to brackish marshes, sandy beaches and low dunes, tidal flats and marsh ridges. It can inhabit foredunes and primary dunes, and can survive in saturated soil conditions (Stalter, 1974; Stalter and Lamont, 1997; van der Valk, 1975). This grass is adapted to a wide range of soils from coarse sands to silty clay sediments with a pH range of 4.5 to 7.1 (Martin, 1959). Saltmeadow cordgrass will tolerate irregular inundations with 0 to 35 parts per thousand salinity and the concentration required for 50% above ground tissue death is about 65 parts per thousand (Hester et al., 2005). Leaf blades have a thick cuticle and usually are involute when fully developed which helps protect the plant from salt spray injury (Oosting, 1945).

Establishment
Saltmeadow cordgrass is usually established by vegetative means. Depending on the energy affecting the planting site, either containerized (high impact sites) or bare root (mild impact sites) plants can be utilized. Bare root material should contain 3 to 5 stems perplanting unit, while containers should have at least 5 to 8 healthy stems. Bare root plugs are generally limited to planting sites that are exposed to little or no wave energy. Since most marsh sites are irregular and difficult to access, hand planting is normally employed, using spades, dibbles, or planting bars. If site conditions are right, planting can be carried out with a mechanical, tractor drawn transplanter. Plant spacing should be between 18 and 36 inches; up to 2 feet of lateral spread can be expected annually (Craig, 1991; USDA, 2007).

Pests and Potential Problems
The toxic ascomycete ergot (*Claviceps purpurea*) has been observed to parasitize the ovaries of saltmeadow cordgrass. The infection can be transferred to other grass species including big cordgrass (*Spartina cynosuroides)* and smooth cordgrass (*Spartina alterniflora*) (Eleuterius and Meyers, 1974).

Environmental Concerns
None at this time.

Control
Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method.

Seeds and Plant Production
Saltmeadow cordgrass is commonly propagated vegetatively. It has little ability to spread through seed production and the seedlings have low vigor. In nursery rows, plants of saltmeadow cordgrass should be spaced 6 to 12 inches apart. Under ideal nursery conditions, each planting unit should be able to yield up to 50 stems in a single growing season. Effective weed control is essential to producing quality plants.

Cultivars, Improved, and Selected Materials (and area of origin)
Saltmeadow cordgrass is easily found in nurseries, garden stores and other plant dealers and distributors. There are several named cultivars available on the commercial market. In 1986, 'Avalon' (New Jersey) saltmeadow cordgrass was released for use in the coastal area north of the Carolinas by the Cape May Plant Material Center (PMC), in Cape May Court House, New Jersey. Soon after, 'Flageo' (North Carolina) was released by the Americus, Georgia and Brooksville, Florida PMCs for use on southern Atlantic and Gulf coasts. 'Sharp' (Louisiana) was released in 1994 by the Florida and Georgia PMCs for coastal back dune stabilization in the southern Atlantic and Gulf coast counties from Florida to Texas. It is also suited for use in inland areas from southern Georgia to southern Arkansas to stabilize shorelines, gullies, road banks, mine spoils, saline oil seep areas, and for nutrient reclamation in agricultural and municipal waste water irrigated fields. In 2003, 'Gulf Coast' marshhay cordgrass was released from the Golden Meadow PMC near Galliano, Louisiana for marsh restoration, shoreline and levee stabilization, stabilizing dredge fill sites, and restoration of coastal beaches and dunes. 'Gulf Coast' is found to be adapted to the coastal areas of Louisiana, Mississippi, and Texas.

References

Abuzeineh, A. A., R. D. Owen, N. E. McIntyre, C. W. Dick, R. E. Strauss, and T. Holsomback. 2007. Response of marsh rice rat (*Oryzomys palustris*) to inundation of habitat. Southwestern Naturalist 52(1):75-78.

Barkworth, M. E. 2003. *Spartina* Schreb. In: Barkworth, M. E., K. M. Capels, S. Long, and M. B. Piep eds. Magnoliophyta: Commelinidae (in Part): Poaceae, Part 2, Flora of North America North of Mexico, Volume 25. New York: Oxford University Press. 240 – 250.

Burger, J. and J. Shisler. 1983. Succession and productivity on perturbed and natural *Spartina* salt-marsh areas in New Jersey. Estuaries 6(1)50-56.

Courtemanche Jr, R. P., M. W. Hester, and I. A. Mendelssohn. 1999. Recovery of a Louisiana marsh

plant community following extensive hurricane-induced overwash. Journal of Coastal Research 15(4):872-883.

Craig, R. M. 1991. Plants for coastal dunes of the Gulf and South Atlantic Coasts and Puerto Rico. USDA-Natural Resources Conservation Service. Agriculture information Bulletin 460. 41pp.

DeLaune, R. D., S. R. Pezeshki, A. Jugsujinda, and C. W. Lindau. 2003. Sensitivity of US Gulf of Mexico coastal marsh vegetation to crude oil: comparison of greenhouse and field responses. Aquatic Ecology 37(4):351-360.

Eleuterius, L. N. and S. P. Meyers. 1974. *Claviceps purpurea* on *Spartina* in coastal marshes. Mycologia 66(6):978-986.

Gould, F. W. 1975. The Grasses of Texas. College Station, Texas. Texas A&M University Press. 653 pp.

Hester, M. W., E. A. Spalding, and D. D. Franze. 2005. Biological resources of the Louisiana coast: Part 1. An overview of coastal plant communities of the Louisiana Gulf shoreline. Journal of Coastal Research Special Issue No. 44:134-145.

Martin, W. E. 1959. The vegetation of Island Beach State Park. Ecological Monographs 29(1):2-46.

Oosting, H. J. 1945. Tolerance to salt spray of plants of coastal dunes. Ecology 26(1):85-89.

Oregon Department of Agriculture. 2006. Noxious weed policy and classification system. http://www.oregon.gov/ODA/PLANT/WEEDS/Pages/lists.aspx. Oregon Department of Agriculture. Verified 25 February, 2013.

Sauer, J. 1967. Geographic reconnaissance of seashore vegetation along the Mexican Gulf Coast. Baton Rouge, Louisiana: Louisiana State University Press. 59pp.

Sei, M. 2009. Flight and oviposition behavior of the adult maritime ringlet (*Coenonympha nipisiquit* McDunnough) females in response to microhabitat. Journal of Insect Behavior 22(2): 87-100.

Stallins, J. A. 2002. Dune plant species diversity and function in two barrier island biogeomorphic systems. Plant Ecology 165:183-196.

Stalter, R. 1974. Vegetation in coastal dunes in South Carolina. Castanea 39(1): 95-103.

Stalter, R. 1993. Barrier Island Botany. The Southeastern United States. Dubuque, Iowa: Wm. Brown. 164pp.

Stalter, R. 2003. Barrier Island Botany – A Guide to Barrier Island Plants from Cape Cod, Massachusetts to Assateague Island, Virginia. Fort Washington, Pennsylvania: Eastern National. 72pp.

Stalter, R. and E. E. Lamont. 1997. Flora of North Carolina's Outer Banks, Ocracoke Island to Virginia. Journal of the Torrey Botanical Society 124(1): 71-88.

Stutzenbaker, D. D. 1999. Aquatic and Wetland Plants in the Western Gulf Coast. Austin, Texas: University of Texas Press. 465 pp.

USDA. 2007. Planting Guide for Establishing Coastal Vegetation on the Mississippi Gulf Coast. USDA-Natural Resources Conservation Service Jamie L. Whitten Plant Materials Center, Coffeeville, Mississippi. 38pp.

van der Valk. A. G. 1975. The floristic composition and structure of foredune plant communities of Cape Hatteras National Seashore. Chesapeake Science 16(2):115-126.

Voss, E. G. 1972. Michigan Flora – A Guide to the Identification and Occurrence of Native and Naturalized Seed-Plants of the State. Bloomfield Hills, Michigan: Cranbrook Institute of Science and University of Michigan Herbarium. 488pp.

Wang, J., D. M. Seliskar, J. L. Gallagher, and M. T. League. 2006. Blocking *Phragmites australis* reinvasion of restored marshes using plants selected from wild populations and tissue culture. Wetlands Ecology and Management 14(6):539-547.

Washington Administrative Code. 2005. State noxious weed list and schedule of monetary penalties, Chapter 16-750. http://apps.leg.wa.gov/WAC/default.aspx?cite=16-750 . State of Washington. Verified 25 February, 2013.

Prepared By: USDA Rose Lake Plant Materials Center. East Lansing, Michigan.

Citation

Leif, J. 2013. Plant Guide for saltmeadow cordgrass (*Spartina patens*). USDA-Natural Resources Conservation Service, Rose Lake Plant Materials Center. East Lansing, Michigan 48823

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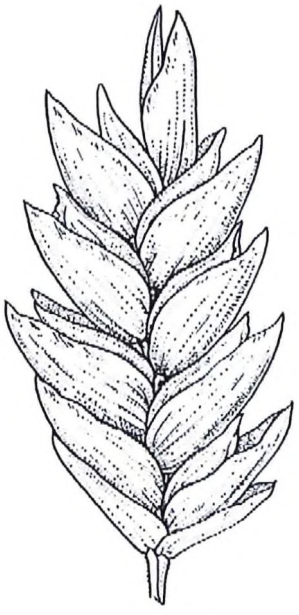
Plant Guide

SALTGRASS

Distichlis spicata (L.) Greene

Plant Symbol = DISP

Contributed by: USDA NRCS National Plant Data Center & the Louisiana State Office



Hitchcock (1950)
Texas A&M University

Alternate Names

Inland saltgrass, seashore saltgrass, spike grass, and alkali grass

Uses

Livestock: Under favorable soil and moisture conditions, studies have shown Saltgrass favorable for pastures irrigated with saline water. The total dry matter yields were 9081 kg/ha with a total protein production of 1300 kg/ha. Saltgrass is grazed by both cattle and horses and it has a forage value of fair to good because it remains green when most other grasses are dry during the drought periods and it is resistant to grazing and trampling. It is cropped both when green and in the dry state; however, it is most commonly used the winter for livestock feed. Saltgrass along the Atlantic coast was the primary source of hay for the early colonists.

Wildlife: Saltgrass is a larval foodplant for the Wandering Skipper (Panoquina panoquinoides errans) butterfly. It is also an important food in the diet of waterfowl and the Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*), which is on the Endangered and Threatened Species List of Southeastern United States. Ducks are reported to occasionally eat the dried seeds and controlled burning provides tender forages for wild geese. *Distichlis spicata* is significant in the salt marshes, which provide nesting grounds for birds, fish and larvae of many species of marine invertebrate animals. As salt marsh plants decompose, their stored nutrients provide a steady source of food for clams, crabs, and fish.

Wetland Restoration: The thick entangled roots of salt marsh plants acts as a guard between the ocean and the shore protecting the land from pollutants and other chemicals associated with runoff water. It is particularly useful in saline/alkaline wetlands.

Medicine: Saltgrass is a respiratory allergenic plant that is offered by Miles Pharmaceutical and used by Florida physicians to treat respiratory allergies.

Spice: Indians that inhabited California used saltgrass as a seasoning. They collected the salt crystals by threshing the blades. The seasoning provided is gray-green and said to have tasted like a salty dill pickle.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Grass Family (Poaceae). Inland saltgrass is a native, dioecious low, glabrous perennial, with scaly rhizomes. Culms are erect, varying in heights of 1.5 – 4.5 dm, less tall in dense colonies. Lower leaves consist of sheaths only, which are overlapping and glabrous. Sheath margins are scarious and sparsely ciliated apically. Leaves are mostly cauline and vertically two-ranked. Blades are firm, the edges often flat at the base and folded or rolled inward meeting in the middle, therefore, appearing attenuate. Blades are generally less than 10 cm long. Salt crystals may be found on the leaves and stems. The ligules are stiff, membranous and apically ciliate. Ligules range in lengths between 0.2-0.5 mm long.

The inflorescences are dense, spike-like panicles, which range from 5-7 cm long or less. Spikelets are 3-10 flowered and are laterally flattened.

Disarticulation is above the glumes and between the florets. The two glumes are unequal in size. Glumes are keeled and hard on the back. The margins of the glumes are scarious; the first glume is 1-3 nerved and 1.5-2.5 mm long. The second glume is 3-5 nerved and 2-3 mm long. The lemmas are rounded on the back and have 9-11 faint nerves. Lemmas are acute to cuspidate and 3-4 mm long. The lemma margins are scarious. Paleas are 2-nerved, 3-5 mm long, falcate, and are sharply keeled, the keel very finely hispid-ciliate. The palea margins are scarious and are in-rolled.

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment
Adaptation: Saltgrass is found in saline areas, brackish marshes, and in salt flats along the coasts of the Atlantic and Pacific Oceans, the Gulf of Mexico and the along the coast of South America. It inhabits upper/high marsh (irregularly flooded) areas, in which the water levels vary between 2 inches above the soil surface and 6 inches below the soil surface. It is also commonly present in the dry West, where it is one of the most drought-tolerant species. Saltgrass is located in both organic alkaline and in saline soils. It is found in planting zones 7,8,9,and 10. Distichlis spicata can be found in flower from June to October. The inflorescence is yellowish in color, turning straw brown as it dries.

General: It may be propagated by seeds, which are produced many times in a growing season and are dispersed by wind and water. It is easier and more often propagated by its extensively creeping underground rhizomes.

Rhizomes: Saltgrass can be established by seeds or by rhizome cuttings. If using rhizome cuttings, they must not dry out. They may be stored up to 28 days. It is recommended that the rhizomes be stored in a temperature range of 35-50° F and in 60-75% relative humidity. Rhizomes are can be planted any time of the year at a depth of 1-2 inches. However, rhizomes sprout better at 77-86° F.

Seeds: Saltgrass seeds demand more than rhizomes to sprout. The seeds need moist soil, low alkalinity and high temperatures. Although many seeds are produced, only a small percentage of those seeds may germinate naturally.

Management
Saltgrass can be managed by burning between September 1 and February 1 biannually, when the water level exceeds the soil surface. Following burning, four inches of re-growth should be obtained before grazing is allowed. Water control systems may need to be installed to maintain correct water levels to avoid prolong inundation, which kills saltgrass. Cattle walkways are usually installed to make the forage more accessible.

Pests and Potential Problems
Saltgrass is the alternate host for the red rust (*Puccinia aristidae*, also known as *Puccinia subnitens*) that infects spinach. Although the red rust disease is difficult for shippers to detect, it grows rapidly during transit. Since little is known about this disease, there are no recommended control techniques. Saltgrass eradication has been the only method used so far because the pathogen cannot complete its life cycle without this alternate host plant.

Control
This species can behave invasively in some situations. Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Cultivars, Improved, and Selected Materials (and area of origin)
'LK517f saltgrass' is a California native, perennial, warm season grass with extensive creeping, yellowish, scaly rhizomes forming large colonies. Establishment should be in late spring using rhizomes or plugs planted on one-foot centers. Irrigation water should be applied the first summer to ensure stand establishment. LK517f is used for riparian restoration and bank and shoreline stabilization.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

References

Ahlgren, G.H. 1956. *Forage crops*. McGraw Hill Book Company, Inc., New York, New York. 7 p.

Allen, C.M. 1992. *Grasses of Louisiana*. 2nd ed. Cajun Prairie Habitat Preservation Society, Louisiana. 96 p.

Austin, D.F. 1998. *Respiratory allergenic plants*. AUG00. http://www.fau.edu/divdept/science/envsci/allergy.html

Bentley Community College 1997. *Salt marshes*. AUG00. http://web.bentley.edu/sum97/ns314/ecosystems/saltcomm.htm1

Comer, W.L. & D.G. Lugg 1983. *Yield and quality of saltgrass (Distichlis spicata (L.) Greene) grown in two soils and several salinities*. Western Society of Crop Science Abstracts. AUG99. http.//ectc.ext.missouri.edu:70/R13180-14574-1m/info/wscs/abstracts/83.html

The University of Arizona 1997. *Arizona range grasses*. College of Agriculture, Cooperative Extension. AUG99. http://phylogeny.arizona.edu/pubs/natresources/az97105/desert_saltgrass.html

Colorado State University 1996. *Red rust on spinach*. Cooperative Extension Pest Alert Bulletin, Vol. 13, No. 7 May 31, 1996. Red Rust on Spinach. AUG99. http://www.colostate.edu/Depts/IPM/news/pestalrt/Vol13/pest13-7.htm

USDI, FWS 1992. *Endangered and Threatened tpecies of southeastern United States (The Red Book) FWS Region – 4 As of 11/92*. AUG99. http://www.fws.gov/r9endspp/i/a/saa98.html

Godfrey, R. K. & J.W. Wooten 1979. *Aquatic and wetland plants of Southeastern United States – Monocotyledons*. University of Georgia Press, Athens, Georgia. 213 p.

Gordon–Garrison, M. 1994. *Gardening naturally*. AUG00. http://sdcc12.ucsd.edu/~wa12/garden11.94.html

Kim, J.G. & B. Grenwell 1999. *UCD wetlands lab/wetland plants*. AUG99. http://www.des.ucdavis.edu/wetlands/plants/ds.html

Leithead, H.L., L.L. Yarlett, & T.N. Shiflet 1971. *100 native forage grasses in 11 southern states*. USDA Handbook No. 389. 83 p.

Oregon Coast.Com 1999. *Neterts Bay· Oregon coast – salt marsh & mudflats*. http://www.oregoncoast.com/Netarts/nbay3.htm

Sampson, A.W. 1924. *Native American forage plants*. John Wiley & Sons, Inc., New York, New York. 172 pp.

Struttman, J. 1999. *Butterflies of New Jersey*. USDI, GS, BRD, Northern Prairie Wildlife Research Center. AUG00. http://www.npwrc.usgs.gov/resource/distr/lepid/BFLYUSA/nj/5159.htm

Szalay, F.A. & V.H. Resh 1996. *Responses of wetland invertebrates and plants important in waterfowl diets to burning and mowing of emergent vegetation*. Wetlands 17: (1996). AUG99. http://www.sws.org/wetlands/abstracts/volume17n1/SZALAY.html

Uchytil, R.J. 1990. *Distichlis spicata*. IN: *The fire effects information system* [Database]. USDA, Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory, Missoula, Montana.

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Plant Guide

STURDY BULRUSH

Schoenoplectus robustus (Pursh) M.T. Strong

Plant Symbol = SCRO5

Contributed by: USDA NRCS National Plant Data Center

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Alternative Names
bulrush, alkali bulrush, three cornered rush, leafy three-cornered sedge, stout bulrush

Uses
Wildlife: Sturdy bulrush seeds are an important food source to muskrat, waterfall, ducks, geese, and other water birds. This species also provide cover for nesting birds.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Description
General: Sedge family (Cyperaceae). Sturdy bulrush is native, perennial sedge that grows up to three and a half feet tall. The leaves are grasslike, long and narrow, up to twenty-four inches long. The flowers are born in three or more spiklets that are covered by brown scales (Tiner 1987), flowering between April and August. The fruit is a dark brown or black achene with pits that fruit between July and October.

Distribution: Sturdy bulrush grows from Maine, south to Florida and west to Texas. For current distribution, please consult the Plant profile page for this species on the PLANTS Web site.

Adaptation
Sturdy bulrush occurs in swampy meadows, along streams, swamps, sloughs, and borders of oxbow lakes in river flood plains. This is a wetland species that grows best in *Schoenoplectus* communities with water levels between –6 and +5 inches with a soil pH ranging from 4.3 to 6.4.

Establishment
Propagation by Seed: Sturdy bulrush seeds should be sown in a cold frame as soon as they are ripe in a pot standing in three centimeters of water. The seeds germinate quickly. When they are large enough to handle, out-plant into their permanent positions in early summer.

Large divisions can be planted directly into their permanent positions. It is best to pot smaller divisions and grow them in a cold frame and out-planting when they are well established in the summer.

Management
After seed planting, water level over sturdy bulrush seeds should be maintained at one foot for two weeks. Periodic flooding up to three feet should occur until the seedlings are established.

Cultivars, Improved and Selected Materials (and area of origin)
Available through commercial nurseries dealing with wetland plants. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the

phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

References

Gleason, H.A. 1952. *The new Britton and Brown. illustrated flora of the northeastern United States and adjacent Canada*. Vol 1. The New York Botanical Garden, Bronx, New York.

Godfrey, R.K. & J.W. Wooten 1979. *Aquatic and wetland plants of southeastern United States· monocotyledons*. The University of Georgia Press, Athens, Georgia.

Hitchock, L.C. & A. Cronquist 1973. *Flora of the Pacific Northwest*. University of Washington Press, Seattle, Washington.

Howell, J.T. 1949. *Marin Flora: manual of the flowering plants and ferns of Marin County, California*. University of California Press, Berkeley & Los Angeles, California.

Munz, P.A. 1965. *A California flora*. University of California Press, Berkeley & Los Angeles, California.

Munz, P.A. 1973. *A California flora and supplement*. University of California Press, Berkeley, California.

Radford, A.E., H.E. Ahles, & C.R. Bell 1968. *Manual of the vascular flora of the Carolinas*. The University of North Carolina Press, Chapel Hill, North Carolina.

Small, J.K. 1933. *Manual of the southeastern flora*. The University of North Carolina Press, Chapel Hill, North Carolina.

Strausbaugh, P. D. & E. L. Core 1977. *Flora of West Virginia*. 2nd ed. Seneca Books, Inc., Morgantown, West Virginia.

Tiner, R.W. Jr. 1987. *A field guide to coastal wetland plants of the northeastern United States*. The University of Massachusetts Press, Amherst, Massachusetts.

University of Florida 2002. Center for Aquatic and Invasive Plants, Gainsville, Florida. Accessed: 11jan02. <http://aquat1.ifas.ufl.edu/welcome.html>

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Plant Guide

NARROWLEAF CATTAIL

Typha angustifolia L.

Plant Symbol = TYAN

Contributed By: USDA, NRCS, National Plant Data Center & Idaho Plant Materials Center

Alternate Names
flags, rushes, bulrushes, cat o'nine tails, Cossack asparagus, reed mace, baco

Brother Alfred Brousseau
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Uses
Caution: This species can be very invasive in disturbed wetlands. Please read about the environmental concerns under Management.

Ethnobotanic: All parts of the cattail are edible when gathered at the appropriate stage of growth. The young shoots are cut from the rhizomes (underground stems) in the spring when they are about 4 to 16 inches long. The base of the stem where it attaches to the rhizome can be boiled or roasted like potatoes. The young flower stalks can be taken out of their sheaths and can be boiled or steamed just like corn. Cattail pollen is a fine substitute for flours. It is a bright yellow or green color, and turns pancakes, cookies or biscuits a pretty yellow color (which children love). The rhizomes and lower stems have a sweet flavor and can be eaten raw, baked, roasted, or broiled. Cattail rhizomes are fairly high in starch content; this is usually listed at about 30% to 46%. The core can be ground into flour. One acre of cattails would yield about 6,475 pounds of flour (Harrington 1972). This flour would probably contain about 80 % carbohydrates and around 6% to 8% protein. Since cattails occur around the world, it is a potential source of food for the worlds' population.

The Klamath and Modoc peoples of northern California and southern Oregon made flexible baskets of twined cattail. Cattails were also twined to form mats of varying sizes for sleeping, sitting, working, entertaining, covering doorways, providing shade, and a myriad of other uses. Lengths of cattail were plied into rope or other size cordage, and cattail rope was used in some areas to bind bundles of tule into tule boats. Air pockets or aerenchyma in the stems provided the buoyancy for good boat-building material.

The Cahuilla Indians used the stalks for matting, bedding material, and ceremonial bundles (Barrows 1967). Some tribes used the leaves and sheath bases as caulking materials. Apaches used the pollen in female puberty ceremonies. After dipping the spike in coal oil, the stalk makes a fine torch. The fluff can also be used as tinder, insulation, or for lining baby cradleboards. The down is used for baby beds (Murphey 1959).

Wildlife: The multitudes of tiny, wind-carried seeds are too small and too hairy to be attractive to birds (Hotchkiss and Dozier 1949). In a few exceptions, the seeds are eaten by several duck species. Cattail rootstocks are much more valuable as food for wildlife than are the seeds. Geese and muskrats prefer the stems and roots. Moose and elk eat fresh spring shoots. Shelter and nesting cover are provided for long-billed marsh wrens, redwing blackbirds, and yellow-headed blackbirds.

Conservation: This plant is used widely for wetland restoration and constructed wetlands for tertiary water treatment. *Typha* species can become invasive in disturbed habitats.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Description
Cattails are herbaceous, colonial, rhizomatous, perennial plants with long, slender, green stalks topped with brown, fluffy, sausage-shaped flowering heads. *Typha angustifolia* plants are 15-30 dm tall.

The spike-like, terminal, cylindric inflorescence has staminate flowers above and pistillate flowers below. The naked axis between the staminate and pistillate flowers is generally 1-8 cm. The spike is medium to dark brown. The basal leaves are thin with parallel veins running their long, narrow length. The leaves are 4-12 mm wide when fresh, 3-8 mm wide when dry.

Typha angustifolia generally occurs in deeper water than *Typha latifolia*. *Typha angustifolia* has fewer and larger rhizomes, resulting in a low rate of cloning but enabling it to grow in deeper water than *Typha latifolia*. *Typha angustifolia* has a higher allocation to sexual reproduction. Cattails spread both vegetatively and by seed, particularly under drawdown conditions.

Distribution

Cattails are always found in or near water, in marshes, ponds, lakes, and depressional areas. They are obligate wetland indicator plant species. Cattails tolerate perennial flooding, reduced soil conditions, and moderate salinity. With influxes of nutrients or freshwater, cattails are aggressive invaders in both brackish salt marshes and freshwater wetlands. Narrow-leaved cattails are found in marshes at elevations <2000 m. They grow throughout North America and Eurasia (Hickman 1993). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment

Typha species may be planted from bare rootstock or seedlings from container stalk or directly seeded into the soil. Bare rootstock or seedlings are preferred revegetation methods where there is moving water. *Typha* seeds germinate readily and are a cost-effective means to propagate cattail on moist soils. *Typha* species can be invasive in disturbed wetland situations and become a monoculture.

Seed Collections

- Select seed collection sites where continuous stands with few intermixed species can easily be found and obtain permission for seed collection.
- Seeds can be harvested when they are slightly immature. It is important to harvest the staminate stalks before they dry and blow away.
- Harvest by using either hand clippers, cutting the stem off below the seed heads, or by stripping the seed heads off of the stalk. Use a seed cleaner to process the seeds. Dry and store the seeds in brown paper or burlap bags.
- Plant cleaned seed in fall. Plant in clean, weed-free, moist seedbed. Flooded or ponded soils will significantly increase seedling mortality.
- Broadcast seed and roll in or rake 1/4" to 1/2" from the soil surface. Some seed may be lost due to scour or flooding. Recommended seed density is unknown at this time.

Seed Germination in Greenhouse

- Plant in the greenhouse in 1" x 1" x 2" pots, 1/4" under the soil surface. Keep soil surface moist. Greenhouse temperature should be 100° F (plus or minus 5° F). Seeds will begin to germinate after a couple weeks in warm temperatures.
- Plants will be ready in 100-120 days to come out as plugs. By planting seeds in August, plugs are ready to plant in the soil by November. These plants are very small. Growing plants to a larger size will result in increased revegetation success.

Live Plant Collections

- No more than 1/4 of the plants in an area should be collected. If no more than 0.09 m^2 (1 ft^2) is removed from a 0.4 m^2 (4 ft^2) area, the plants will grow back into the hole in one good growing season. A depth of 15 cm (6 in) is sufficient for digging plugs. This will leave enough plants and rhizomes to grow back during the growing season.
- Donor plants that are drought-stressed tend to have higher revegetation success.
- Live transplants should be planted in moist (not flooded or anoxic) soils as soon as possible. Plants should be transported and stored in a cool location prior to planting. Plugs may be split into smaller units, generally no smaller than 6 x 6 cm (2.4 x 2.4 in), with healthy rhizomes and tops. The important factor in live plant collections is to be sure to include a growing bud in either plugs or rhizomes. Weeds in the plugs should be removed by hand. For ease in transport, soil may be washed gently from roots. The roots should always remain moist or in water until planted.
- Clip leaves and stem from 15 to 25 cm (6 to 10 inches); this allows the plant to allocate more energy into root production. Plant approximately 1 meter apart. Plants should be planted closer together if the site has fine soils such as clay or silt, steep slopes, or prolonged inundation.
- Ideally, plants should be planted in moist soils in late fall just after the first rains (usually late October to November). This enables plant root systems to become established before heavy

flooding and winter dormancy occurs. Survival is highest when plants are dormant and soils are moist.
- Fertilization is very helpful for plant growth and reproduction. Many more seeds are produced with moderate fertilization.

Management
Heavy grazing will eliminate *Typha* species, as well as other native species, from riparian corridors. However, cattails are fairly resistant to moderate grazing, providing wet soils are not compacted.

Because cattails have relatively little value for ducks, they are often regarded as undesirable weeds in places intended primarily for ducks. It has been found that mowing cattails after the heads are well–formed, but not mature, then following up with another mowing about a month later (when new growth is two or three feet high) will kill at least 75% of the plants. This will enable other emergent vegetation with more palatable and nutritious seeds to become established.

Environmental Concerns: Ecologically, cattails tend to invade native plant communities when hydrology, salinity, or fertility change. In this case, they out-compete native species, often becoming monotypic stands of dense cattails. Maintaining water flows into the wetland, reducing nutrient input, and maintaining salinity in tidal marshes will help maintain desirable species composition. If cattails begin to invade, physical removal may be necessary.

Over the past century, we have dramatically increased the range of this species and have brought *T. angustifolia* and *T. latifolia* together with the production of the hybrid *T. glauca*. This taxon is extremely aggressive and will out-compete either parent. The methods of control include clipping and floocing >12 inches, herbicides, and hydrology management (Melvin 2000). Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Cultivars, Improved and Selected Materials (and area of origin)
Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials. This species is readily available for native plant nurseries specializing in wetland plants.

References

CalPhotos 2000. *Typha angustifolia.* <http://elib.cs.berkeley.edu/cgi/img_query?seq_num=11010&one=T>. Version: 000321. CalFlora, Inc., Berkeley, California.

Clarke, C.B. 1977. *Edible and useful plants of California.* University of California Press. 280 pp.

Grace, J.B. 1985. *Juvenile vs. adult competitive abilities in plants: size-dependence in cattails (Typha).* Ecology 66(5):1630-1638.

Grace, J.B. & R.G. Wetzel 1982. *Variations in growth and reproduction within populations of two rhizomatous plant species: Typha latifolia and Typha angustifolia.* Oecologia 53:258-263.

Grace, J.B. & R.G. Wetzel 1981. *Phenotypic and genotypic components of growth and reproduction in Typha latifolia: Experimental studies in marshes of differing successional maturity.* Ecology 62(3):699-801.

Harrington, H.D. 1972. *Western edible wild plants.* The University of New Mexico Press. 156 pp.

Hoag, J. C. & M.E. Sellers (April) 1995. *Use of greenhouse propagated wetland plants versus live transplants to vegetate constructed or created wetlands.* Riparian/Wetland Project Information Series No. 7. USDA, NRCS, Plant Materials Center, Aberdeen, Idaho. 6 pp.

Hickman, J.C. 1993. *The Jepson manual. Higher plants of California.* University of California Press. 1399 pp.

Hotchkiss, N. & H.L. Dozier. *Taxonomy and distribution of North American cat-tails.* Am. Midl. Nat. 41:237-253.

Keator, G., L. Yamane, & A. Lewis 1995. *In full view. Three ways of seeing California plants.* Heyday Books, Berkeley, California.

Melvin, N. 2000. *Personal communication.* USDA, NRCS, National Wetland Science Institute, Laurel, Maryland.

Roos-Collins, M. 1990. *The flavors of home. A guide to wild edible plants of the San Francisco bay area.* Heyday Books, Berkeley, California. 224 pp.

Shay, J.M. & C.T. Shay 19??. *Prairie marshes in western Canada, with specific reference to the ecology of five emergent macrophytes.* Can. J. Bot. 64:443-454.

USDA, NRCS 2000. *The PLANTS database.* Version: 000321. <http://plants.usda.gov>. National Plant Data Center, Baton Rouge, Louisiana.

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Plant Guide

SMOOTH CORDGRASS

Spartina alterniflora Lois.

Plant Symbol = SPAL

Contributed By: USDA NRCS Louisiana State Office

Alternative Names
saltmarsh cordgrass, oystergrass, saltwater cordgrass

Grass Images
Texas A&M University

Uses
SE US Coastal & Shoreline Restoration: Smooth cordgrass is a unique plant species that when established properly and under applicable conditions has proven to provide significant erosion protection to shorelines, canal banks, and other areas of coastal wetland loss.

Smooth cordgrass is used primarily for erosion control along shorelines, canal banks, levees, and other areas of soil-water interface. In addition, smooth cordgrass is an effective soil stabilizer used on interior tidal mudflats, dredge-fill sites, and other areas of loose and unconsolidated soils associated with marsh restoration. When established in conjunction with shorelines, smooth cordgrass provides an effective buffer that dissipates energy, reduces shoreline scouring, and traps suspended sediments and other solids. Dense stands of smooth cordgrass are efficient users of available nutrients, producing significant amounts of organic matter. The cumulative effects of organic matter production, sediment trapping, and erosion control not only provide shoreline protection but also accelerate sediment accumulation and near-shore building. Consequently, smooth cordgrass is a sustainable and renewable restoration resource, and when properly established and in the appropriate habitat, will persist and potentially remain effective indefinitely.

Status
Smooth cordgrass is a native species critical to Barrier Island and wetland restoration along the southeastern coastal states, while it is introduced into areas on the Pacific coast, where has become an aggressive invasive species. Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Weediness
Smooth cordgrass has been introduced along the U.S. West Coast and is very invasive. Consult the links found at the bottom of the PLANTS Plant Profile for additional information regarding this species along the Pacific coast, particularly in California and Washington.

Description
General: Smooth cordgrass is a herbaceous, native, warm season grass that forms dense vegetative colonies along shorelines and inter-tidal flats in coastal wetlands. Smooth cordgrass is a robust, rapidly spreading plant, tolerant to fluctuating water depths and salinity. Smooth cordgrass spreads primarily by vegetative propagation, producing new stems from an extensive system of underground rhizomes. Plant height will vary according to site conditions, but generally will range from 24" to 72." Colonies tend to grow parallel to and continuous along shorelines; the width and thickness of a vegetative colony is controlled by a number of site-specific conditions such as elevation, shoreline-slope, and frequency, depth, and duration of flooding.

Distribution: Generally, this species occurs in the coastal states along the U.S. It is not native on the West Coast. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment

Adaptation: Smooth cordgrass is an inter-tidal brackish plant species. It is described as a facultative halophyte; that is, it will tolerate salt, but salt is not a requirement for its growth. Smooth cordgrass can be established in freshwater, however, numerous field trials have demonstrated that smooth cordgrass is difficult to establish and will not persist under freshwater field conditions. The ideal salinity range for establishing and growing smooth cordgrass is 8 to 33 parts per thousand or brackish to saline habitats. Smooth cordgrass can be established and will persists in areas of elevated salinity (such as salt-flats and tidal lagoons), however plants in high saline habitats tend to be stubby and less robust, generally resulting in thinner and more open vegetative stands.

Of primary importance in site selection is that the site be inter-tidal. Smooth cordgrass is critically sensitive to reduced soil sulfides, a condition common to anaerobic and brackish marsh soils. Smooth cordgrass should not be planted outside of the tidal zone. Smooth cordgrass will tolerate fluctuating water levels. Optimum water depths for establishing plants are 1" to 18". Plantings in deeper water have been successful, however plants are slow to anchor and vegetative cover is sparse. Consequently, plants are more prone to washout, and minimal shoreline protection is achieved.

Smooth cordgrass is adapted to a wide range of soils from coarse sands to clays and mucks. Plant establishment and productivity appear to be superior on heavier mineral soils such as mucky clays, silty clays, silty clay loams, and fine sands. Soils with very high levels of organic matter pose structural problems and have proven to be problematic in establishing stands of smooth cordgrass.

Considerations: There are a number of other site-specific elements that should be considered when working with smooth cordgrass. These conditions represent extremes and should be thoroughly investigated prior to committing to a significant project if any of these conditions occur.

- Soil load-bearing properties -- It is not uncommon for soils (especially in dredge deposit sites) to be fluid to the point that they physically will not support the weight of plants. This is an indicator of soils with a very high water-to-mineral ratio.

- High organic soils – Smooth cordgrass will not survive in soils with extremely high levels of organic matter. These soils are described as having very low bulk density and are problematic. When soil texture approaches the consistency of peat moss, there is potential for low plant survival.

- Poor water circulation – Smooth cordgrass is critically sensitive to sulfide accumulations and has a relatively low tolerance to sulfide toxicity.

- Shoreline configuration – Abrupt and steep cut-banks are indications of high wave energy and/or highly erodible soils. Special precautions may be required to keep transplants from dislodging prior to becoming established.

- Herbivore grazing – Smooth cordgrass is a favorite of numerous grazing animals. In areas of heavy nutria population, caging plants may be required to protect newly planted material.

- Smothering – Precautions should be taken when planting in areas of heavy floating debris. Both mechanical damage to the plants from surf-trash and smothering from water hyacinths are common.

If any of these conditions are present, consult with a wetland specialist for additional information and/or possible alternatives.

Planting: Smooth cordgrass is a poor seed producer. Although plants appear to produce a significant number of seeds, most seeds are empty, damaged, or sterile. Consequently, seed fertility is low. For planting purposes, two forms of vegetative plant materials are recommended: containerized and bare-root plugs. Both plant forms have shown to be equally successful in establishing plant stands when planted properly and on applicable sites. There are no commercially available sources of seed, and seeding is not currently a recommended practice.

Smooth cordgrass can be produced in a number of container sizes, however trade-gallons are the most widely used and most popular size. Trade-gallon containers have a higher per unit cost compared to smaller containers or bare-root plugs, but provide the most reliable means of establishment. Trade-gallon plants have proven to be a highly successful transplant, especially along shorelines and other areas of high wave energy.

A trade-gallon will have 5 to 12 aerial stems that are 18" to 24" in height. Smooth cordgrass produces new tillers (stems) and spreads almost entirely from rhizomes. Consequently, a well-developed root mass

is critical to the survival and productivity of transplants.

Bare-root plugs are the most economical of the commercially available plant sizes. Per unit production costs are low and transportation costs are very low compared to container plants. Bare-root plugs are generally limited to planting sites that have little or no energy exposure. Typical sites would include mudflats, sediment disposal areas, terraces, or other interior and protected sites. Bare-root plugs because of their limited surface area will not persist in high-energy environments. They tend to dislodge prior to establishing. Bare-root plugs have significantly less rootmass than container plants, will suffer a higher level of transplant shock, and are slower to spread than container plants. However, if handled properly and used on an applicable site, bare-root plugs can be highly successful transplants.

Bare-root plugs typically consist of 3 stems 12" to 18" in height, and stems should remain attached at the root. Plugs should have a rootmass of at least 2" in diameter at the root crown and 6" of root length.

A complete description (specification) for both trade-gallon container plants and bare-root plugs is available from the Natural Resources Conservation Service in Louisiana.

Planting Date: As a general rule, smooth cordgrass can be planted between April 1 to September 30. Some additional considerations include the following:

- Smooth cordgrass can be planted anytime past the last frost date if there is a need to plant earlier and available transplants are actively growing. In some areas this may be earlier than April 1.

- In interior marshes with poor water circulation, avoid planting between mid-July and the end of August. Elevated water temperatures are generally detrimental to new transplants; therefore July and August plantings should be limited to lakes, bayous, and other areas of frequent tidal exchange.

- Late fall plantings in October and November have been successfully made in the past, but should be limited to sites that are well protected and have minimal winter storm effect.

Planting Location: It is critically important to remember that smooth cordgrass is strictly an inter-tidal plant species and must be planted within the inter-tidal zone. Smooth cordgrass can be used for erosion control along shorelines, canal banks, levees, and other areas of soil-water interface. In addition, smooth cordgrass is an effective soil stabilizer used on interior tidal mudflats, dredge-fill sites, and other areas of loose and unconsolidated soils associated with marsh restoration.

Shoreline Plantings: Shoreline plantings are typically planted as a single row parallel to the shoreline. Transplants should be planted at the mid-point between the high and low tide elevations. Plant spacing within the row will vary according to the size of the transplant materials being used and the rate at which full coverage is desired. Trade-gallons generally are planted on 5' to 8' centers and plugs generally on 2' to 3' centers. Under applicable site conditions, smooth cordgrass will spread laterally filling spaces between plants and will grow up to its highest elevation and down to its lowest elevation. It is not uncommon for smooth cordgrass to produce 8' to 10' of lateral spread in one growing season.

Depending on site conditions and the planting objective, two rows of smooth cordgrass are occasionally planted. A two-row planting will provide quicker and denser short-term coverage than a single-row planting. If two rows are planted, rows should be parallel to each other and about 5' apart using the same plant spacing within row as that of a single row. The first row should be placed slightly above the mean tide elevation and the second row 5' below the first. Plants within the two rows should be staggered on center so that plants alternate between spaces.

Interior Plantings: In addition to planting shorelines, smooth cordgrass can also be used along terraces, levees, across mudflats and dredge-fill sites. The planting configuration should be designed to provide maximum reduction in fetch lengths. Rows can be placed across shallow water exchange points to create a passive hydrologic barrier that will slow tidal exchange and trap suspended sediments. Planting large areas generally will require a significantly large number of plants. Where applicable, plugs can be used and placed in a row-column configuration. The row and plant spacing can vary from a few feet to many, depending on the objective of the planting, the target rate for coverage, and available resources.

Planting Methods: When planting trade-gallons, transplants should be planted in a dug hole. Post-hole diggers, gas drills with modified bits, or any other methods of digging are satisfactory. The planting hole should be the same size or only slightly

larger than the root-ball and deep enough so that the top of the root-ball is flush or slightly below ground. The top of the root-ball should not protrude above nor be more than 2" below normal ground. The planting hole should be tightly closed around the plant to prevent the plant from wobbling and plants should remain erect after planting.

Planting sites where high wave energy is a problem may require the addition of a plant anchor. A plant anchor consists of ¼" mild steel re-bar bent into a crosier hook (candy-cane shape) and pushed down into the soil so that hook lays across the root-ball, pinning it to the ground. Anchors are generally about 30" in overall length and will add to the cost of the planting. However, anchors are generally necessary at unusually problematic sites to prevent plants from washing out.

When planting bare-root plugs, holes need only be approximately 3" in diameter and deep enough to cover the roots. Any style of tool that will punch a hole this size such as a dibble bar will work. Cupping the roots of the plug in hand and pushing down into the mud carefully will also work in more fluid soils. There are no plant anchors for plugs, and in practice plugs should not be used at any site where wave energy is a factor.

Fertilization: There is no clear consensus on the effectiveness of fertilizer when used in saturated and/or anaerobic soils. However, the additional cost of fertilizer is a small investment given the overall cost involved in vegetative restoration. High nitrogen slow-release fertilizer tablets will add approximately .08 to .10 cents to the cost of an individual plant.

Slow-release fertilizer tablets are commercially available in a range of weights and analyses. Recommended tablet weight should be between 15 and 25 grams and have a nitrogen content of not less than 15% or more than 30%. When using tablets with trade-gallon plants, push the tablet into the top 3" of the root-ball immediately prior to or immediately after planting the transplant. The resulting hole should be pinched closed. When using tablets with bare-root plugs, drop the tablet in the planting hole prior to inserting the plug.

Cultivars, Improved and Selected Materials (and area of origin)

There are two known cultivars, 'Vermilion' and 'Bayshore'. Vermilion was released in 1989 for use in the Gulf of Mexico northern basin, and Bayshore was released in 1992 for use on the Atlantic Coast. The Natural Resources Conservation Service Plant Materials Program released both.

Plant materials are generally obtained from two sources, a donor wetland site or commercial nurseries. The use of donor wetlands to obtain young plants will eventually affect the health and vigor of the donor stand regardless of the care taken in frequency, spacing, and location of plant removal. In addition, the removal of plant materials without the applicable permits may be in violation of standing state and federal regulations. Removing plant materials from donor stands is not recommended.

Nursery-grown stock is generally the most reliable and ecologically appropriate way to obtain plant materials. There are a number of commercial nurseries that produce and maintain smooth cordgrass transplants. Trade-gallon and vegetative plugs are the two most common sizes, however most nurseries will contract for other container sizes. Smooth cordgrass seed is currently not commercially available.

Vegetative specifications should be used to tailor plant material quality and quantity to a specific project. These specifications should include acceptable sources, cultivars, ecotypes, plant size, stem height, container specifications, and extent of root development. In addition, other requirements such as climatic hardening, salt hardening, procedures for transportation and handling are commonly included.

A list of commercial wetland plant nurseries and assistance in developing plant material specifications is available from the Natural Resources Conservation Service in Louisiana.

References

Alderson, J. & W.C. Sharp 1994. *Grass varieties in the United States*. Agriculture Handbook No. 170. USDA, SCS, Washington, D.C.

Callaway, J. C., & M. N. Josselyn 1992. *The introduction and spread of smooth cordgrass (Spartina alterniflora) in south San Francisco Bay.* Estuaries 15:218-226.

Hitchcock, A.S. 1951. *Manual of the grasses of the United States*. USDA, Washington, D.C.

Linthurst, R. A., & E. D. Seneca 1980. *Dieback of salt-water cordgrass (Spartina alterniflora Loisel.) in the lower Cape Fear Estuary of North Carolina: An*

experimental approach to reestablishment. Environ. Cons. 7:59-66.

Texas A&M University 1997. *Grass images*. <http://www.csdl.tamu.edu/FLORA/image/poacr2ba.htm>. Bioinformatics Working Group, College Station, Texas.

USDA, NRCS 2000. *The PLANTS database*. Version: 000504. <http://plants.usda.gov>. National Plant Data Center, Baton Rouge, Louisiana.

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